D.2.1 Water Governance Framework of Social Acceptability

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Executive summary

Macaronesian islands—the Azores, Canary Islands, Madeira, and Cape Verde—face intensifying water security challenges driven by climate change, increasing demand, and aquifer depletion. Nature-based solutions (NBS) offer ecosystem-based approaches to enhance groundwater recharge, improve water quality, and build climate resilience. However, realising this potential depends fundamentally on social acceptability and effective governance frameworks that enable collaborative, transparent, and adaptive implementation. This deliverable presents a comprehensive analysis of social acceptability and participatory governance for NBS in Macaronesian water management, fulfilling the objectives of GENESIS Work Package 2 Task 2.1 through mixed-methods research that combines stakeholder surveys, semi-structured interviews with key players, public perception assessments, regulatory analyses, and international best practice reviews.

Strong support for nature-based solutions exists across all regions, with over 70% of stakeholders viewing NBS as environmentally sound, technically appropriate, and culturally compatible with local values. This endorsement transcends institutional boundaries, spanning government officials, technical professionals, agricultural producers, and citizens. Importantly, traditional practices, including rainwater harvesting, terracing, and check dams, align conceptually with contemporary NBS frameworks, enabling interventions to be framed as an enhancement of ancestral ecological wisdom rather than alien impositions. This cultural compatibility strengthens social legitimacy and provides culturally resonant narratives for public engagement, demonstrating that communities are ready to embrace NBS when enabling conditions exist.

Yet implementation faces significant structural barriers. Financial constraints, cited by 52-70% of respondents depending on region, represent the single most critical obstacle. Limited technical capacity, institutional fragmentation, regulatory ambiguity, and performance uncertainty constitute additional primary barriers, while cultural resistance was rarely mentioned. The absence of dedicated financing mechanisms, combined with public budgets favouring conventional infrastructure, creates systematic impediments even where political will exists. Technical capacity gaps reflect limited professional training in ecological engineering and the absence of standardised protocols adapted to island conditions. Institutional architectures fragment responsibilities across multiple agencies without effective coordination mechanisms. Regulatory frameworks designed for conventional infrastructure create uncertainty about permitting requirements, water rights allocation, and liability arrangements, discouraging investment. These obstacles are structural rather than social—they can be addressed through policy reform, capacity building, and institutional innovation.

Regional diversity requires tailored approaches. While commonalities across archipelagos enable knowledge transfer, critical differences in economic capacity, institutional maturity, and dominant water challenges necessitate context-specific adaptation. The Azores exhibit strong social capital favouring community-based co-management but require technical capacity development for managed aquifer recharge. The Canary Islands possess sophisticated technical capacity but face institutional fragmentation requiring multi-stakeholder platforms. Madeira needs strengthened municipal capacity alongside regional coordination. Cape Verde faces acute resource constraints demanding modular, low-cost approaches with adaptive learning. These differences support flexible

governance frameworks offering multiple models rather than prescriptive uniform approaches.

Governance quality determines whether strong social support translates into successful implementation. Social acceptability depends fundamentally on inclusivity, transparency, accountability, and responsiveness of decision-making processes. Scientists and NGOs emerged as the most trusted actors, suggesting that governance processes positioning them as facilitators and independent evaluators can leverage credibility while mitigating distrust of purely government-led initiatives. Participatory monitoring, transparent financial reporting, and meaningful community involvement in project design were consistently identified as essential for maintaining confidence and social licence.

The deliverable presents three complementary participatory governance models addressing different scales and contexts. Community-Based Co-Management establishes formal partnerships between authorities and local communities through Local Water Management Committees, appropriate for small-to-medium-scale projects in cohesive communities with direct livelihood dependence on water. Multi-Stakeholder Platforms create coordination mechanisms bringing together diverse institutional actors to guide water management at the watershed, island, or regional scales, addressing fragmentation through structured collaboration and joint planning. Adaptive Collaborative Governance establishes flexible, learning-oriented arrangements for contexts with high uncertainty, embracing uncertainty through structured experimentation, systematic monitoring, and explicit adjustment protocols. These models are not mutually exclusive but represent different scales of participatory engagement. Practitioners can select appropriate models based on local context, combine elements into hybrid configurations, or implement phased evolution as capacity develops.

Strategic recommendations span five thematic areas. Institutional and regulatory reforms should formalise NBS within legal frameworks through amended water legislation with clear permitting pathways, establish inter-agency coordination mechanisms across governance levels, integrate NBS into river basin management plans and climate adaptation strategies, and clarify water rights for managed aquifer recharge. Financial measures should develop dedicated NBS financing mechanisms, coordinate regional applications to EU programmes (LIFE, Cohesion Fund, Horizon Europe), implement payment for ecosystem services schemes, and establish economic valuation standards capturing co-benefits. Capacity development should create Macaronesia NBS training programmes, develop technical guidance materials adapted to island conditions, establish communities of practice connecting practitioners across archipelagos, and integrate NBS into professional curricula. Demonstration priorities should implement strategic pilot portfolios generating credible local evidence, design projects as governance experiments testing participatory approaches alongside hydrological performance, establish regional data sharing platforms, and document successes and challenges transparently. Communication strategies should frame NBS through heritage connections and traditional knowledge, integrate into school curricula, position scientists and NGOs as primary communicators, and establish citizen science programmes.

The path forward is clear. Communities already recognise water challenges, understand ecosystem-based approaches, trust scientific guidance, and maintain cultural practices compatible with NBS social acceptability is not the limiting factor. The barriers are structural: fragmented institutions, constrained budgets, incomplete regulatory frameworks, and limited technical capacity. All are remediable through concerted action. Participatory governance emerges as a practical necessity for overcoming these obstacles. Inclusive, transparent, accountable decision-making processes build trust, enabling innovation, integrate diverse knowledge systems, improving designs, distribute

costs and benefits equitably, sustaining support, and create adaptive capacity responding to uncertainties. The governance framework provides practical templates for GENESIS demonstration sites while offering broader guidance for Macaronesian water authorities advancing NBS beyond project timelines. Success depends on sustained political commitment, adequate resourcing, genuine embrace of collaborative principles, and patience with participatory processes that generate more robust, legitimate, and durable outcomes than top-down approaches. By treating demonstration projects as governance experiments and learning platforms rather than purely technical trials, Macaronesia can become an international exemplar of participatory, ecosystem-based approaches to water security—demonstrating that islands, though vulnerable, are also laboratories for sustainable, resilient, socially legitimate water futures that all communities increasingly require.

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1 Introduction

This work explores the social, institutional, and technical landscape shaping the implementation of Nature-based Solutions (NBS) and innovative water management approaches across the Macaronesian archipelagos. Building on the region's shared environmental challenges and unique governance contexts, the study aims to identify the barriers, challenges, and opportunities that influence the uptake of NBS in Macaronesia and in similar island analogues.

To achieve this, relevant scientific research and examples of best practice from Europe and beyond are reviewed and consolidated, providing a foundation for contextual analysis. The work further defines key parameters that underpin successful participatory water governance, focusing on models that promote collaboration, transparency, and shared decision-making among institutions, experts, and citizens.

A participatory water governance framework is developed to reflect these principles, integrating innovative co-management and co-decision-making mechanisms tailored to the realities of Macaronesian islands. The framework is informed by a comprehensive assessment of the legal and policy context in each study area, together with detailed stakeholder analysis and mapping to identify key actors, institutional linkages, and local influencers shaping water governance processes.

Empirical data were collected through focus groups and semi-structured interviews with stakeholders from each island and demonstrator site, offering valuable insights into local perceptions, experiences, and priorities. To complement this qualitative understanding, a Macaronesia-wide citizen survey conducted in two native languages and examined broader public perceptions of climate resilience, groundwater resources, and NBS feasibility. Together, these activities provide an integrated understanding of social acceptance, institutional readiness, and perceived challenges and opportunities for NBS across the four archipelagos.

1.1 Background and rationale

In Macaronesia, the water infrastructure is anticipated to experience negative consequences of climate impacts. Rising temperatures will lead to heightened water demand for purposes such as consumption and irrigation, particularly during warmer periods, potentially resulting in temporary water scarcity. Alterations in precipitation patterns will result in diminished freshwater availability, decreased soil moisture, reduced surface water and groundwater levels, as well as impaired groundwater recharge capacity. Extreme weather events, such as intensified storms, have the potential to overwhelm the sewer system's capacity to manage collections, leading to increased instances of flooding and untreated sewage discharge into water bodies. Additionally, projections of rising sea levels are likely to induce contamination of freshwater aquifers, escalated evaporation, intrusion of saltwater due to sea-level rise, and disturbances in the water treatment processes. Climate change adaptation strategies in Macaronesia are of utmost importance. The European Green Deal[1] outlines a route toward climate neutrality and sustainable development, underpinned by substantial investments in environmentally friendly technologies and innovation.

The disruption, corruption, or dysfunction of infrastructure necessary to produce, transport, treat, store, distribute, and remove drinking water and wastewater and also to control water quantity and quality, would have a debilitating effect on security, regional economic security, public health or safety, or any combination thereof. Thus, assets, the system or part thereof of the Water System Sector, are considered a Critical Infrastructure [2,3]. Water critical infrastructures, which hold indispensable importance for human well-being, life, and public health. These infrastructures face the looming threats of climate change, which could lead to severe societal repercussions. The discourse surrounding environmental issues finds its focal point in the Water Sector, given that water is unequivocally the most vital natural resource worldwide. The complex global challenges related to water resources, including the impacts of climate change, burgeoning population, rapid urbanization, and ageing infrastructure, continue to escalate.

1.2 Objectives

To perform the work described above as explicitly referred in Task 2.1 in the grant agreement, the following objectives have to be met and reported in this deliverable:

1) Review of relevant research and best practices.
2) Identification of barriers and opportunities
3) Stakeholder analysis.
4) Legal framework assessment.
5) Characterise Regional Perceptions and Readiness for NBS Implementation
6) Establish a Framework for Participatory Water Governance.

1.3 Linkages within Genesis

The report contributes directly to Work Package 2 (Societal acceptance and participatory governance) and provides foundational insights for Work Package 2's subsequent tasks, Work Packages 3 and 4, which address technical demonstration and policy alignment. Specifically, it identifies the barriers, challenges, and opportunities influencing the adoption of NBS and innovative water management strategies across the islands. By consolidating scientific research and reviewing best practices from Europe and beyond, the work supports the GENESIS objective of building a transdisciplinary evidence base for sustainable water governance in data-scarce, climate-vulnerable regions.

2 Methodological approach

The methodological framework adopted a mixed-methods and triangulated design integrating qualitative and quantitative evidence to examine perceptions, practices, and regulatory frameworks related to water management and NBS. The approach combined empirical data collection through statistically structured surveys and semi-structured interviews with a systematic literature and legislation review, ensuring both scientific depth and policy relevance. The methods were aligned with Horizon Europe's standards for Responsible Research and Innovation (RRI), emphasising transparency, inclusivity, and data interoperability under findable, accessible, interoperable and reusable (FAIR) principles.

The literature review was directed to identify existing best practices and technological approaches in water management and aquifer recharge; clarify conceptual frameworks linking NBS, ecosystem services, and groundwater governance; and define knowledge gaps and research priorities to be addressed through field surveys and stakeholder engagement.

A legislative mapping exercise was undertaken to identify and analyse the legal and regulatory instruments governing water use and nature-based solutions implementation across the selected regions of Madeira, Azores, Canary Islands, and Cape Verde. The review combined EU-level instruments such as the Water Framework Directive 2000/60/EC, Groundwater Directive 2006/118/EC, the Environmental Impact Assessment Directive, and the Common Implementation Strategy for managed aquifer recharge; and regional and local regulations such as national decrees, water codes, and environmental framework laws, including concession, permitting, and monitoring regimes.

Structured surveys were designed to capture quantitative insights into stakeholder awareness, willingness, and perceived barriers related to NBS and groundwater management. The questionnaire was co-developed with project partners and validated through pilot testing to ensure clarity and cultural relevance across the Macaronesian islands. The survey included:

- Closed-ended Likert-scale questions to measure attitudes, willingness, and perceived benefits,
- Categorical variables on institutional type, expertise, and experience with NBS,
- Open comment fields for qualitative insights.

Data were collected via the EU survey online platform and in-person workshops, ensuring balanced representation from public authorities, private operators, academia, and civil society. Sampling was purposive but aimed for diversity across gender, sector, and island geography. Ethical approval and informed consent procedures were applied according to the EU's General Data Protection Regulation (GDPR).

To complement the quantitative data, semi-structured interviews were conducted with key informants from water authorities, geological institutes, municipal governments, farmers' associations, and NGOs. The interview guide was structured around six themes:

1. Governance and institutional coordination,
2. Technical experience with NBS,
3. Socio-economic and cultural factors influencing adoption,
4. Data availability and monitoring practices,

5. Regulatory and permitting challenges,
6. Perceived risks and opportunities for upscaling.

Interviews were recorded (with consent), transcribed, and anonymised. Transcripts were analysed using thematic coding, applying both deductive (based on pre-defined categories) and inductive (emergent) coding strategies to ensure contextual sensitivity.

Data from surveys and interviews were analysed using a multi-level analytical framework combining descriptive statistics, comparative analysis, and thematic synthesis. The Quantitative analysis was based on frequency distributions, cross-tabulations, and correlation analyses were used to identify trends in stakeholder responses. The Qualitative analysis, directed on thematic analysis, identified recurring narratives, perceptions, and contextual barriers. Results were aggregated across islands to extract cross-cutting regional patterns. Finally, the data emerged as information by integration through triangulation, combined both datasets to validate findings and derive composite insights into technical, social, and institutional enablers of nature-based solutions (NBS).

A strengths, weaknesses, opportunities, threats (SWOT) framework was then developed for each island, summarising the perceived readiness and gaps in implementing water-related NBS. All results were synthesised into an integrated interpretation framework linking the empirical evidence with legislative and scientific findings.

This deliverable used AI assistance (GPT-5, OpenAI) as a supportive tool for statistical data analysis. The AI system assisted under author supervision with statistical computation and data interpretation, including descriptive and multivariate analyses of survey and interview data. It did not create new data, and all quantitative outputs were independently verified by the authors against project datasets and cited documentation. No personal or sensitive data was shared with the tool. The data was anonymised prior of use. All AI-assisted content underwent multi-step human review and editorial oversight by P. Tyrologou and Vitor Correia, who retain full responsibility for the analyses, results, and conclusions. The work complies with the COPE (February 2023) principles on the transparent and responsible use of artificial intelligence in research.

3 Review of relevant research and best practices

Genesis' nature-based solutions fall under the green infrastructure and are well aligned with the United Nations Sustainable Development Goals especially the UNSDG 6 Clean water and Sanitation. Despite this and the scientific support that spans over a decade, NBS is still not widely adopted and faces skepticism. On the same note, degradation of freshwater ecosystems can be a major driver of disaster and conflict risk that can undermine sustainability [4-6].

Nature-based solutions (NBS) offer multilayer advantages, resilience and sustainability combined with financial gains on the long term. When applied in water management, they can restore or even enhance hydrological and hydrogeological functionality [7]. In cases, water management NBS may also offer additional services such as flood defence mechanisms with stormwater retention. NBS are more cost-effective due to lower maintenance costs and deliver sustainably on multiple ecosystem services compared to grey infrastructure that may deliver quicker but great environmental impacts on the long term and address only limited needs [8]. It should be noted that the term Nature-Based Solutions encompasses a very wide range of solutions for many purposes. For the purposes of the project GENESIS and this report, the NBS described are related to managed aquifer recharge (MAR) techniques. As such, this chapter presents a non-exhaustive but still critical review of current research and practices on implementing NBS based on managed aquifer recharge techniques. There is a variety of MAR techniques used in the past and in the present. These are presented below together with the operational framework for the current practices.

3.1 Learning from past practices

The implementation approach adopted, together with obstacles and opportunities is not different from other parts of the world, especially in developing countries that has limited access to funds [9-11]. On the same note recent research calls more on embedding cultural ecosystem services into NBS by considering ancestral wisdom to address water challenges and thus achieve higher community penetration and embracement [12]. UNESCO provides typical examples of past practices that deploying nature based solutions for water management in places under stress are:

1) The indian stepwells that draw water from an underground aquifer (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/indian-stepwells, web page visited 12/11/2025).
2) The Oman falaj water supply, traditional water mining system (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/omanic-aflaj, web page visited 12/11/2025).
3) The Venice Cistern system, dense network of underground rainwater cisterns (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/venetian-cisterns, web page visited 12/11/2025).
4) The Algerian circular irrigation system, capture surface water from the hydrological cycle and divert it in local loops for human use (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/algerian-oasis, web page visited 12/11/2025).

5) The Morocco system of Khettaras .i.e. water galleries that utilizes also thermal excursion, (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/moroccan-khettaras, web page visited 12/11/2025).
6) The Mexican Tecuates, a system of canals by raising, leveling, and compacting the soil (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/mexican-tecuates, web page visited 12/11/2025).
7) The Chilean System of Socavónes, filtration galleries (https://www.watermuseums.net/campaigns/valuing-ancient-water-cultures/chilean-socavones, web page visited 12/11/2025).

For an exhaustive list of agricultural examples of traditional practices from all over the world that deploy water NBS the reader is referred to the FAO Land and Water Discussion Paper no. 12, 2018 [8] as well as the Catalogue of Nature Based Solutions for infrastructure projects [13].

3.2 Framework for current practices

Best practice starts with designing the intervention as an NBS, which requires clear societal goals, robust safeguards, and measurable outcomes. The updated IUCN Global Standard emphasises context analysis, participatory design, adaptive management, and transparent monitoring so that recharge actions demonstrably deliver resilience, biodiversity, and equity benefits alongside hydrologic gains [14]. In the European Union, policy alignment through the Water Framework [15] , groundwater protection [16] and Floods Directives[17], the 2025 EU "common implementation strategy on both aforementioned directives on managed aquifer recharge (MAR) [18] clarifies how recharge can support good status objectives, drought adaptation, and flood risk reduction, provided schemes manage quality risks, respect groundwater-dependent ecosystems, and follow precautionary permitting. Chapter 4 provides more information on the legislative framework for NBS and MAR.

Building on these policy foundations, current practice in Europe and internationally recognises that successful MAR projects are those integrated within catchment-based water management plans and co-designed with local stakeholders. The IUCN [14] and UNESCO [19] guidelines stress the importance of aligning technical feasibility with social and ecological context. This translates to that recharge actions must be embedded in broader strategies that consider land use, soil conservation, and ecosystem services. Effective NBS-driven recharge schemes therefore, go beyond engineering solutions to embrace community stewardship, long-term maintenance responsibilities, and continuous learning cycles informed by monitoring and evaluation [20].

From a technical perspective, the state of practice is guided by risk-based planning frameworks [21-25]. These include systematic assessment of hydrogeological suitability, source water quality, and aquifer vulnerability, followed by design selection that minimises environmental risks and maximises multi-benefit outcomes. The European Commission's MAR guidance [18] highlights that recharge methods such as infiltration basins, recharge wells, or riverbank filtration should be selected according to site-specific characteristics, hydrological objectives, and ecological sensitivities [26]. Adaptive management plans are required to handle operational issues like clogging, changing recharge rates, or evolving water quality conditions.

In parallel, the monitoring, reporting and verification dimension of NBS and MAR has evolved significantly [27-29]. Modern frameworks incorporate high-frequency data acquisition using piezometers, tracers, and geophysical tools to quantify recharge volumes, residence times, and water quality evolution, which are already part of the GENESIS project. Monitoring programmes now explicitly link hydrologic indicators with ecological and social co-benefits, for example, tracking not only groundwater levels but also vegetation recovery, biodiversity metrics, and user satisfaction. Data transparency and interoperability are also considered best practice, following the FAIR principles (Findable, Accessible, Interoperable, and Reusable) to support open science and cross-project comparison [30,31].

Institutionally, the framework for current practices promotes multi-level governance [32], where water authorities, municipalities, research institutions, and end-users collaborate within shared decision-making platforms. This approach aligns with the European Green Deal's [1] emphasis on integrated water and nature management, ensuring that NBS-based recharge contributes simultaneously to the objectives of the Water Framework Directive [15], the Biodiversity Strategy (https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en, visit:14/11/2025), and the Zero Pollution Action Plan (https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en, visit: 14/11/2025). Public participation and social acceptance are therefore recognised as central to the long-term viability of MAR projects, helping to balance groundwater abstraction, recharge, and ecosystem protection [19,32].

3.3 Managed aquifer recharge practices

NBS for groundwater aim to restore natural recharge, attenuate floods and droughts, and secure water quality while delivering co-benefits for ecosystems and communities. In current practice, managed aquifer recharge (MAR) is an encompassing concept that includes a suite of purposeful recharge of suitable waters to aquifers for later recovery or environmental benefit. MAR encompasses spreading methods such as infiltration basins and ponds, riverbank filtration, and channel modifications, each is selected to fit hydrogeology, available source water, and management objectives. Current advancements on governance treat NBS as an ecosystem solution that enhances water security with performance criteria and shifts away from the traditional approach that treated MAR as a purely engineering add-on [4,33,34].

By shifting a portion of storage from evaporative surface reservoirs to the subsurface, MAR treats aquifers as natural infrastructure that can buffer seasonal variability, provide pretreatment through soil–aquifer processes, and mitigate hazards such as seawater intrusion and land subsidence. Success depends on tight coupling between the recharge method, the hydrogeological setting, the source-water characteristics, and the operational regime chosen to sustain performance over decades rather than years [9-11,35-37].

Proper scientific approaches take into consideration hydrogeologic suitability with land-use feasibility and ecological sensitivity. Coarse-textured vadose zones with adequate unsaturated thickness favour infiltration ponds and on-farm recharge; bank-filtered wellfields suit alluvial corridors where induced infiltration can be tightly monitored; fractured or confined settings often require wells for MAR. Current guides stress integrating recharge with catchment plans and prioritising multi-benefit approaches. When well designed and governed, MAR delivers a suite of co-benefits that extend beyond volumetric storage. As water moves through soils and aquifers, biogeochemical processes reduce pathogens and biodegradable organics, sorb or transform many trace contaminants, and promote redox transitions that attenuate nitrate in suitable settings. In coastal aquifers, strategically placed injection welllines and hydraulic mounds thicken

freshwater lenses and push back saline interfaces, protecting production wells from upconing [38]. At the landscape scale, additional subsurface storage sustains river baseflows, supports phreatophytic vegetation, and can reduce subsidence in overdrafted basins. These services accrue only if water levels are kept within acceptable bounds and if recovery is managed to avoid undesirable mixing or mobilization of legacy contaminants [7,11,13,38,39].

Site characterisation establishes the hydrology and hydrogeology, permeability, storage coefficients, as well as the baseline water quality. Conceptual designs are then validated with demonstrators measure infiltration decline, diagnose clogging mechanisms, and observe groundwater mounding or pressure responses under controlled loading. Monitoring networks of piezometers and observation wells are installed along expected flow paths to track heads, electrical conductivity or chloride, dissolved oxygen, nutrients, dissolved organic carbon, and other needed parameters; where potable endpoints are involved, tracers and residence-time analyses verify the multiple-barrier design.

Subsurface injection via wells or boreholes places water directly into confined or semi-confined horizons when surface infiltration is impractical or land is scarce. With this technical approach, aquifer storage employs a single well for both injection and abstraction, simplifying infrastructure and enabling rapid drawdown during peak demand. Injection offers near-instantaneous recharge with negligible evaporative loss and can be effective in fractured, karstic, or deeply buried aquifers; however, it demands high and consistently controlled source-water quality to avoid physical, biological, and chemical clogging of well screens and formation pore spaces, and it carries higher unit costs for pretreatment and maintenance [9,10]. However, if injection and recovery wells increase the subsurface travel time, then the method exploits natural attenuation before water is returned to supply [9,11].

Surface-spreading approaches recharge unconfined aquifers by percolation through the vadose zone and are often preferred where permeable soils coincide with available land. Infiltration basins and ponds divert water into shallow earthworks designed to maximise infiltration while managing the inevitable formation of a clogging layer. Typical hydraulic loading spans from tens of metres per year in finer soils to several hundred metres per year in clean, coarse sands, provided that basins are cycled through wetting and drying, first-flush flows are bypassed when excessively turbid, and periodic scarification or scraping restores permeability. Where terrain is irregular or agricultural, networks of shallow ditches and furrows distribute water thinly across large areas, enhancing contact with the soil matrix and promoting soil regeneration, albeit with higher routine upkeep to control vegetation, sediment, and local erosion [8,40-46].

Induced recharge exploits hydraulic gradients near rivers, lakes, or canals. By pumping from bank-side wells or galleries, operators draw surface water through the riverbed and adjacent sediments, gaining natural filtration, pathogen attenuation, and organic-matter reduction before abstraction. This technique performs best in alluvial settings with reactive sediments and stable stages that secure sufficient residence time; it is widely used for drinking-water pretreatment and to stabilise baseflows during dry periods. In ephemeral or flashy systems, streambed modifications such as low bunds or check structures increase water contact time with the bed and banks, progressively enhancing infiltration without large impoundments. At larger scales, recharge dams capture flood peaks, spread water across downstream alluvium, and release it gradually to minimise evaporation while building subsurface storage; these structures require topography that allows broad, shallow inundation and careful management of fine sediments to preserve void space [10,11,29,36,37].

Method selection is ultimately a systems problem that weighs aquifer type, land availability, source-water quality, hydrology, and economics [14]. Confined or semi-confined targets and urban sites with high land costs tend to favour well injection while unconfined aquifers with permeable vadose zones and rural footprints lend themselves to spreading basins and ponds. Variable quality sources are generally steered toward surface infiltration, where desilting and natural filtration can be managed at low cost, whereas high-purity sources such as advanced-treated reclaimed water, high-quality river diversions, or desalination off-spec flows are compatible with injection, provided particle control and chemical stabilization are assured. Hydrological regime matters: ephemeral flood pulses align with off-channel basins, recharge dams, and streambed bunds, while perennial flows support bank filtration and controlled off-line diversions. Capital and lifecycle costs must be compared on a consistent basis; injection often concentrates cost in pretreatment and wellfield operation and maintenance, whereas spreading methods trade lower treatment costs for larger land take and earthwork maintenance [11,12,29,33,37] . Below, a brief introduction to the best of current knowledge of MAR techniques is given.

Soakaway trench

A shallow, gravel-filled excavation designed to receive and infiltrate stormwater or treated wastewater directly into the subsoil. It promotes localiSed recharge by allowing slow percolation through the unsaturated zone, typically serving small catchments such as roofs or paved areas.

Swale

A broad, shallow, vegetated channel constructed along a gentle gradient to collect, convey, and infiltrate surface runoff. The vegetation enhances infiltration and pollutant removal through filtration and biological uptake while attenuating peak flows.

Infiltration galleries

An infiltration gallery consists of a network of perforated pipes or masonry conduits buried below ground level, allowing controlled distribution of recharge water over a large area. It facilitates deep infiltration where direct surface infiltration is limited by fine-textured soils or space constraints.

Pervious paving

Pervious or permeable paving uses porous materials for instance, interlocking blocks, porous asphalt, or gravel that allow rainfall and runoff to infiltrate through the surface into an underlying sub-base layer, promoting recharge and reducing urban runoff volumes.

Infiltration basin

An infiltration basin is a shallow, vegetated depression that temporarily stores stormwater, allowing infiltration through the basin floor into the underlying aquifer. It is commonly used in urban catchments to manage both quantity and quality of stormwater while enhancing recharge.

Ditch and furrow system

This system consists of small, parallel earthen channels (furrows) separated by ridges (bunds) designed to spread water across agricultural fields. It enhances soil moisture and percolation, promoting recharge in arid or semi-arid landscapes with intermittent flows.

Open well / borehole

An open well or borehole recharge method involves direct injection or percolation of treated water through an existing or purpose-built well into an unconfined aquifer. It is particularly suited to areas with deep water tables or low surface infiltration capacity.

Recharge shaft

A vertical structure that conveys surface water, stormwater, or treated effluents directly into deeper permeable strata. Shafts are typically backfilled with coarse material to improve percolation and may include silt traps or filters to prevent clogging.

Injection bore

Injection bores (or wells) deliver water under pressure directly into confined or semi-confined aquifers through screened intervals. This technique enables high recharge rates and minimises evaporation losses.

Check dams

Check dams are small, temporary or permanent barriers built across drainage lines or small streams to slow runoff, promote sediment deposition, and enhance infiltration upstream. They are widely used in watershed management to reduce erosion and augment groundwater.

Recharge dams

Recharge dams are larger earthen or masonry structures designed to impound seasonal flows, allowing controlled percolation into the underlying aquifer. They serve both groundwater recharge and flood attenuation while it can sustain baseflows downstream.

Streambed modification

Streambed modification entails reshaping or roughening the bed of ephemeral or perennial streams (e.g., through gravel placement or riffle construction) to increase infiltration and residence time, facilitating vertical percolation to the aquifer.

Catchment management

Catchment management integrates soil and water conservation, land-use planning, and vegetation restoration at watershed scale to improve infiltration and reduce runoff. It underpins all recharge interventions by maintaining soil structure and hydrological connectivity.

Contour bunding

Contour bunding involves constructing small earthen embankments along the contour lines of slopes to intercept runoff, reduce erosion, and encourage water infiltration into the soil profile. It is especially effective in semi-arid agricultural terrains.

Contour trenching

Contour trenches are shallow excavations dug along contour lines to capture rainfall and runoff, reducing slope length and enhancing infiltration. Over time, they promote vegetation growth and improve soil moisture retention.

Gully plugging

Gully plugging uses small check structures made of earth, stone, or brushwood to block active gullies, reduce flow velocity, and trap sediments. The retained water infiltrates slowly, supporting localised groundwater recharge.

Afforestation

It refers to planting trees and vegetation in degraded or barren areas. Root systems improve soil porosity and infiltration capacity, while canopy cover reduces runoff, together enhancing long-term aquifer recharge and ecosystem stability.

Controlled grazing

Controlled or rotational grazing manages livestock access to rangelands to prevent overgrazing and soil compaction. Maintaining vegetative cover enhances infiltration and soil moisture retention, thereby improving recharge potential.

Induced recharge

Induced recharge occurs when pumping from wells near rivers or lakes creates a hydraulic gradient that draws surface water into the aquifer. It is a natural–engineered hybrid technique often used in riverbank filtration schemes.

Over-irrigation

Over-irrigation intentionally applies water beyond crop requirements to promote percolation and aquifer recharge. While effective in some contexts, it must be carefully managed to avoid waterlogging, salinisation, and nutrient leaching.

Leaking water and wastewater pipe networks

Unintended leakage from water-supply and sewer systems can contribute to urban aquifer recharge, although typically unplanned and of uncertain quality. In managed contexts, controlled leakage zones or pressure management can harness this process beneficially.

Sewage disposal by septic tank

In rural and peri-urban settings, effluent percolation from properly designed and maintained septic systems can contribute to local groundwater recharge. However, it requires strict design and siting to prevent contamination of potable aquifers.

3.4 Technical and policy obstacles

The international literature on NBS for water management reveals systematic obstacles that transcend regional boundaries and persist across diverse implementation contexts. Understanding these generic barriers provides essential context for interpreting the Macaronesian-specific challenges documented in Chapter 9, while informing the design of governance frameworks that can proactively address predictable implementation difficulties.

The mainstreaming of NBS into environmental management and climate adaptation strategies faces significant systemic barriers. Existing institutional and regulatory

frameworks often favour grey infrastructure, presenting structural barriers to NBS mainstreaming. At the global (UN) and European Union, level there is a strong advocacy to use and deploy NBS. This has also been expressed in several legislative frameworks in the EU context. However, at the national, regional and local administration levels there is much fragmentation that creates obstacles for the wider NBS adoption. At these levels, it is rare that the term 'NBS' will be used and thus promoted. This dominance permeates public policy, building codes, economic markets, and service provider expertise, reinforcing a perception of NBS as less efficient or riskier than engineered alternatives [14,33]. Furthermore, existing institutional arrangements were not designed to facilitate the cross-sectoral collaboration essential for NBS, which often requires coordination across water, land-use, agriculture, and urban planning domains. Regulatory clarity is frequently absent, with no standardised permitting frameworks tailored to NBS, creating uncertainty for implementers [13]. Policy contradictions across sectors can also undermine NBS viability, particularly when land-use strategies conflict with conservation objectives [14].

Financial constraints and valuation deficits constitute a critical barrier. Current investment patterns reveal that globally, less than 1% of water resource infrastructure financing is allocated to NBS, despite their cost-effectiveness and co-benefits [33,34]. This underinvestment comes from multiple factors, including the absence of standardised methodologies for valuing ecosystem services, which weakens the business case for NBS investment [8,13]. Decision-makers often prioritise solutions with the lowest immediate implementation costs, neglecting the longer-term operational savings and ancillary benefits (e.g., recreation, biodiversity) offered by NBS [38]. The development of innovative financing mechanisms, such as green bonds, water funds, or payments for ecosystem services, remains underdeveloped [34]. Perceptions of higher investment risk associated with NBS, partly due to their longer timescales for benefit realization, further deters public and private capital [47].

Other important factors are local weather conditions, technical capability and know how as well as socioeconomic factors closely linked with stakeholder acceptance [7]. In many cases, adoption of NBS is due to a limited understanding of local hydrology and hydrogeological conditions [11].

One of the major obstacles that has been identified by the infrastructure industry is the lack of standards harmonisation for NBS that will allow them into the mainstream of practice. Procurement procedures and technical standards widely exist and are adopted for grey infrastructure, and the technical community is well aware of them since they have been widely debated, and learning mistakes have been embedded in their implementation, thus creating trust among stakeholders. A persistent lack of operational clarity surrounds NBS, with no universally accepted parameters or standards for defining ecological complexity and long-term stability [47,48].

This ambiguity complicates project design, monitoring, and credibility assessment. Site-specificity is inherent to NBS, precluding "one-size-fits-all" templates and necessitating context-adapted designs, which increases planning complexity and costs [13,38]. Significant knowledge gaps persist regarding the hydrological functions of natural systems (e.g., wetlands, floodplains) compared to engineered infrastructure, leading to an underestimation of NBS performance [33]. Furthermore, there is a critical shortage of specialised engineering expertise required for designing and managing hybrid green-grey systems [13]. By integrating NBS in the same adopted procedures for grey infrastructure, it will become much easier and efficient to adopt them, especially in the tender process. Robust, longitudinal data on NBS performance, cost-effectiveness, and maintenance requirements is scarce due to lack of sufficient systematic monitoring and evaluation within NBS timescales [38,47].

NBS operate over decadal timescales to achieve ecological functionality and provide full benefits. This conflicts with short-term political and investment horizons [34]. This temporal mismatch is exacerbated by inadequate long-term maintenance planning and funding, risking ecosystem degradation, service delivery failure, and loss of public acceptance (e.g., neglected urban green infrastructure causing safety hazards) [38,47]. Crucially, poorly designed NBS can create more problems, such as afforestation projects reducing water availability through inappropriate species selection or exacerbating environmental degradation by disregarding local topography and hydrology, as evidenced by historical failures in large-scale programmes [47]. Adaptive management capacity to respond to changing ecological and climatic conditions is often underdeveloped [13].

Despite growing implementation experience, the evidence base for NBS performance under diverse conditions remains incomplete. Long-term monitoring data spanning multiple hydrological cycles are scarce, particularly for novel interventions or applications in understudied climatic and hydrogeological settings. This evidence deficit creates legitimate uncertainty about effectiveness, durability, and cost-efficiency that conservative decision-makers cite when favouring proven grey infrastructure.

Transferability of results between contexts is complicated by site specificity and the influence of local conditions on NBS performance. Infiltration basin efficiency depends on soil texture, climate, source water quality, and operational protocols in ways that defy simple generalisation. Performance data from one setting may provide limited predictive value for different hydrogeological or climatic conditions, requiring costly site-specific pilots rather than direct adoption of proven designs.

Scale-dependent dynamics further complicate evidence interpretation. Small-scale demonstrations may succeed under intensive management and favourable conditions yet encounter unforeseen challenges when scaled to operational dimensions. Conversely, some NBS benefits—such as landscape connectivity for biodiversity or cumulative aquifer recharge—emerge only at larger scales not readily studied through pilot projects.

These obstacles are neither insurmountable nor universal, but their recurrence across diverse implementation contexts suggests they represent systematic challenges requiring proactive attention in governance design and capacity development. The Macaronesian experience, documented through stakeholder consultation and public perception assessment (Chapter 9), demonstrates how these generic barriers manifest in specific institutional, social, and environmental contexts. Understanding both the universal patterns and the local particularities provides a foundation for developing governance frameworks (Chapter 10) and implementation strategies that address obstacles while leveraging opportunities for NBS advancement in island water management.

3.5 Opportunities for NBS leverage

NBS can optimise water cycles by mimicking natural hydrology. Watershed restoration, soil conservation, and riparian buffer zones enhance groundwater recharge, reduce sedimentation, and improve water quality. In New York City, protecting upstream watersheds through payments for ecosystem services schemes saved $300 million annually in filtration costs [33]. Similarly, Rajasthan's drought mitigation via traditional water harvesting structures increased groundwater storage, restored wildlife habitats, and improved livelihoods for 1,000 villages [47]. These approaches align with the EU Water Framework Directive, offering cost-effective actions 5.

Ecosystem-based adaptation reduces drought impacts through techniques like sand dams and conservation agriculture, which enhance soil moisture retention and food security [14,34]. The IPCC emphasises that sustainable land management via NBS significantly lowers climate vulnerability [34].

Scaling NBS requires mobilizing private capital. Water utilities in Latin America now subsidize upstream landowners for forest conservation, ensuring clean water supplies [33]. Anglian Water's wetland projects, co-funded with NGOs and landowners, demonstrate how NBS reduce regulatory compliance costs while creating habitats [39]. The World Resources Institute estimates NBS could save water utilities up to $110 million over 20 years compared to conventional infrastructure 2. Suggested practises are in the form of green funds, impact bonds, and blended finance tools, along with tax incentives to unlock capital while reduce investment risks and thus secure wide implementation. To overcome regulation fragmentation NBS should be embedded into national and local development plans, promoting early integration, cross-sectoral coordination, and municipal capacity-building.

Transdisciplinary platforms that unite governments, communities, and businesses can overcome jurisdictional fragmentation. Successful cases, like the Solano County Green Stormwater Infrastructure Plan, highlight participatory design processes that align land-use practices with water quality goals. The IUCN's NBS principles emphasise equitable benefit-sharing and landscape-scale implementation, while the UN's "Nature for Water" campaign advocates embedding NBS in national SDG strategies [14,33].

Beyond technical efficacy, NBS advance social equity. Wetland restoration and community-managed forests can empower marginalised groups, including women, in climate decision-making. In India, NBS initiatives elevated women's socioeconomic status through roles in water governance [4,8,11,47].

Digital innovations, including simulation platforms, geospatial planning tools, andAI-assisted monitoring, are improving the precision and adaptability of NBS planning and may well accelerate their implementation due to risk reduction. Further opportunities are explored in chapter 8 as these have been identified during the interview and survey investigation.

4 Regional regulatory context and legal framework

This chapter presents a review of the legislation in place that relates to water management and permitting procedures for water use. The chapter first presents European Union legislation that provides the general framework that governs the procedures together with the ones that are relevant for nature based solutions. The EU legislation provided also covers peripheral legislation that relates to contamination prevention and protection of water resources. Subsequently, the regional legislation is presented that reflects the local needs and has to be area specific. The legislation is presented together with a general description of the water use permit procedure that the local competent authority requires.

4.1 EU policy and legislative sustainable water management framework

The EU Green Deal (COM (2019) 640) responds to the UN Paris agreement and brings together policy linking biodiversity, water, soil, and climate under sustainability and circular-economy goals. Consequently, the EU Adaptation Strategy (2021) promotes resilient, low-regret, NBS, monitoring of resilience benefits, and knowledge sharing via Climate-ADAPT. The EU Biodiversity Strategy 2030 mandates measurable nature gains, positioning nature based solution as a delivery medium for ecological restoration. All these provide the framework where NBS can operate with relevance to water management in Macaronesia or in general for islands that have water shortages and face pressures under climate change.

The following European Union Directives provide the primary legal base for integrated and sustainable groundwater management with the implementation of nature based solutions (NBS):

1. The Water Framework Directive (WFD) 2000/60/EC, establishes the framework for integrated river basin management. Relevant articles for achieving good ecological and chemical status, cost-effectiveness in water planning, and participatory governance are the Art. 4 good status, Art. 8 monitoring, Art. 11 programmes of Measures, including natural water retention measures and Art. 14 public participation.
2. The Groundwater Directive 2006/118/EC sets quantitative and chemical quality standards for groundwater and mandates salinisation control.
3. The Floods Directive 2007/60/EC, complements the WFD through flood-risk management plans while promotes NBS for flood prevention, mitigation, and retention.
4. Drinking Water Directive 2020/2184/EU – ensures safe and equitable access to quality drinking water, supporting source protection and sustainable abstraction.

The WFD and Groundwater Directives address saline-intrusion control and chemical status of aquifers while WFD and Floods Directives require public consultation in river-basin and flood-risk planning. Further to the above core legislation below is presented EU legislation that is peripheral and complements the aforementioned:

1. Marine Strategy Framework Directive (MSFD) 2008/56/EC, protects coastal and estuarine waters; relevant to saline intrusion control and coastal NBS that are relevant to wetlands.
2. Nitrates Directive 91/676/EEC that reduces diffuse agricultural pollution.
3. Waste Framework Directive 2008/98/EC which establishes waste-prevention and soil-protection measures relevant to groundwater quality.
4. Industrial Emissions Directive 2010/75/EU, regulates pollutants that may reach aquifers.
5. REACH Regulation (EC) 1907/2006, governs chemical substances to prevent groundwater contamination.
6. Maritime Spatial Planning Directive 2014/89/EU takes inot account land-sea interactions and integrates coastal-zone management.
7. Marine Strategy Framework Directive (2008/56/EC) monitors coastal habitat condition and salinisation pressures.
8. Seveso III Directive 2012/18/EU, requires risk management for major-accident hazards near water bodies and aquifers.
9. Environmental Liability Directive 2004/35/EC, emphasises the "polluter pays" principle for soil and groundwater damage.
10. Environmental Crime Directive 2024/1203, strengthens enforcement through criminal sanctions for serious environmental offences.
11. Regulation (EU) Nature Restoration (2024/1991), sets binding ecosystem restoration targets (wetlands, rivers, peatlands, urban green areas) and requires monitored outcomes.
12. EU Soil Monitoring Law (COM (2023) 416) forthcoming legislation introduces soil-health indicators and complements NBS in the soil-water retention framework.
13. EU Climate Law (2021/1119), climate neutrality and resilience objectives; with particular reference on NBS and adaptation.

The above legislation ensures groundwater protection from industrial, agricultural, and accidental sources, reinforcing the "no deterioration" and Do No Significant Harm (DNSH) principles embedded in the EU Taxonomy. All legislation provided embeds nature based solutions in the EU's climate-neutrality and biodiversity frameworks, ensuring coherence with restoration targets, carbon sequestration, and resilience planning. Furthermore they provide the context between terrestrial and marine environments, essential for small-island and coastal aquifer systems typical of the Macaronesian context.

4.2 Regional legislation for water abstraction permitting procedure

In the following sections the regional legislation and permitting procedures for Azores, Cape Verde, Gran Canaria and Madeira is presented.

4.2.1 Azores

The permitting procudere for the water use is submitted to the competent regional authority. The documentation typically includes the location plan, property ownership,

hydrological/hydrogeological study (especially for groundwater), proposed volume/flow, intended use, impact assessment, technical drawings of boreholes or galleries. For recharge based on NBS, additional plans for monitoring, maintenance and ecological impact are required.

Once authorised, the abstraction must be registered in the water-use registry. The licence holder is obligated to install flow measurement devices, conduct regular monitoring (e.g., wells, galleries) and submit periodical reports. Conditions may include renewal dependent on monitoring results, maintaining ecological status, compliance with salt-intrusion control.

The applicable permiting regulations are the following:

1. Portuguese national water law: Lei n.º 58/2005, de 29 de Dezembro (Legal Water Regime and Water Resources), sets out public domain of water, need for authorisation of uses, abstraction and groundwater.
2. Decreto Legislativo Regional n.º 19/2003/A, of 23 April, Plano Regional da Água (Regional Water Plan) for the Azores.
3. Decreto Legislativo Regional n.º 8/2023/A, of 27 February , Plano de Gestão da Região Hidrográfica dos Açores 2022-2027 (PGRH-Açores 2022-2027).
4. Decreto Legislativo Regional n.º 9/2023/A, of 8 March, Programmea Regional da Água dos Açores.
5. Decreto Legislativo Regional n.º 1/2025/A, of 2 January, Plano de Gestão de Riscos de Inundações da Região Autónoma dos Açores 2022-2027.

4.2.2 Cabo Verde

In Cape Verde, all significant water abstractions fall under a regulated licensing system designed to safeguard the sustainability of groundwater and surface-water resources. The framework distinguishes between licences (licenças) for smaller-scale or time-limited uses and concessions (concessões) for larger or long-term activities. This regime applies uniformly across all types of water use including potable water, agriculture, or industrial purposes and covers both surface and groundwater.

Minor domestic abstractions for household self-supply are exempt from full licensing requirements, provided they remain below certain thresholds provided in the permit upon the condition that are situated outside designated groundwater protection zones; these smaller uses are typically subject to simple registration.

The Agência Nacional de Água e Saneamento (ANAS) acts as the principal authority for issuing licences and concessions, following a technical and environmental evaluation of each application. Where the proposed works may cause environmental impact, the Direção Geral do Ambiente (DGA) or another competent environmental agency must approve the relevant environmental documentation before the licence can be granted.

The permit procudere involves a prescreening stage where the application defines the proposed location, depth, intended use, and estimated water yield. ANAS then verifies whether the site falls within a legally protected groundwater perimeter or a sensitive hydrogeological zone. Once preliminary clearance is given, the next stage includes a hydrogeological report describing expected recharge and yield, technical drawings of the abstraction infrastructure, and a monitoring plan outlining how flow and water quality will be measured. Proof of land tenure or consent for access to the site, along with payment of administrative fees, must also be provided.

ANAS evaluates aquifer capacity, potential interference with existing users, and risks to the environment. If the project meets the thresholds established by the Environmental Framework Law, an Environmental Impact Assessment (EIA) is required. For smaller or low-risk projects, ANAS may instead request a simplified Environmental Declaration. Once the technical and environmental reviews are completed, the authority issues a licence or concession decision specifying the authorised abstraction rate, total annual volume, and duration of validity, typically five to ten years for a standard licence and up to twenty-five years for a concession. The authorisation also includes operating conditions such as installation of calibrated meters, regular submission of abstraction data, water-quality monitoring, and payment of water-resource fees. Strategic or large-scale projects may require publication of the authorisation in the Boletim Oficial to ensure transparency and public access.

Following approval, licence holders are subject to continuous monitoring and compliance obligations. They must report volumes abstracted and submit periodic quality data according to the schedule set by ANAS. The agency conducts inspections to verify compliance and may impose fines or revoke the licence in cases of over-abstraction, lack of reporting, or environmental damage.

The applying permiting regulations are the following:

1. Código da Água e do Saneamento Decreto-Lei n.º 54/2015, de 18 de Dezembro.
2. Regulamento da Avaliação de Impacto Ambiental (AIA) Decreto-Lei n.º 29/2006, de 6 de Março.
3. Legislative Decree No. 3/2015 – Water and Sewage Code.
4. Decree-Law No. 75/1999 – Legal Regime for Water Use Licences and Concessions.
5. Decree-Law No. 47/2021 – Irrigation Concessions and Management.
6. Decree-Law No. 33/2020 and No. 26/2024 – Água de Rega (ADR), S.A.
7. Environmental Framework Law (No. 86/IV/93, as amended.

4.2.3 Gran Canaria

The permit procedure involves the submission of an application to the competent water authority indicating the use, quantity in volume, location, property ownership, technical works (wells, galleries, pipelines) among other details. The technical documentation includes report on hydrogeology, topographic plans, property and cadastral data, expected volumes (m^3/year, m^3/day), and an impact assesment on neighbouring abstractions or aquifer.

For “small exploitations” the law (Art. 73 of Ley 12/1990) defines the thresholds: e.g., annual volume <2000 m^3, daily volume <20 m^3, used entirely by the owner for their consumption without trade.

Permits are typically granted for a fixed period (e.g., up to four (4) years for small exploitations under the simplified route) and may be renewable if conditions are met.

Once an abstraction is authorised or concessioned, it must be registered in the water-cadastre/registry; the user must meet monitoring/aforo obligations (measurement of flow, volumes, annual accounting), especially for sub-surface wells or galleries.

Conditions on neighbouring abstractions: e.g., when approving a concession for a new well, the hydrogeological study must show no harmful interference within a defined radius or "protective zone" (in one text 3,000 m) of other works.

The applying permiting regulations are the following:

1. Decreto 370/2023, de 18 de septiembre, por el que se aprueba definitivamente el Plan Hidrológico Insular de la Demarcación Hidrográfica de Gran Canaria, tercer ciclo (2021-2027).
2. Decreto 86/2002, de 2 de julio, por el que se aprueba el Reglamento de Dominio Público Hidráulico (https://www.gobiernodecanarias.org/boc/2002/108/001.html).
3. Real Decreto 1085/2024, de 22 de Octubre, por el que se aprueba el Reglamento de reutilización del agua y se modifican diversos reales decretos que regulan la gestión del agua (https://www.boe.es/eli/es/rd/2024/10/22/1085).
4. Ley 21/2013, de 9 de Diciembre, de evaluación ambiental (https://www.boe.es/eli/es/l/2013/12/09/21/con).
5. Ley 12/1990, de 26 de julio, de Aguas de Canarias (https://www.boe.es/buscar/pdf/1990/BOE-A-1990-23087-consolidado.pdf).

4.2.4 Madeira

The permitting process for water use is managed by the Regional Secretariat for the Environment and Natural Resources in coordination with Águas e Resíduos da Madeira (ARM), S.A

The application involves a submission of technical report containing the purpose, location, expected volume, and infrastructure of the intended abstraction. The competent authority goes through a preliminary screening to verify whether the proposed site lies within a protected hydrogeological zone or catchment and determines whether an fully flexed Environmental Impact Assessment or a simplified onedeclaration is required. The regional authority evaluates aquifer capacity, potential interference with existing users, and overall environmental implications before issuing the licence or concession.

Each licence specifies quantitative limits (flow rate and annual volume), operational conditions, and validity duration, which typically ranges from five to ten years for standard licences and longer for strategic uses. Mandatory conditions include flow metering, data reporting, and compliance with water-quality standards. The regional authority performs routine monitoring and inspections to ensure adherence to licence terms and to prevent over-abstraction or contamination. Failure to comply may result in fines or suspension of the authorisation. At renewal, licence holders must update their technical documentation and demonstrate compliance with environmental and reporting obligations. For projects integrating NBS such as infiltration basins, recharge ponds, or ecological irrigation systems the same permitting procedure applies, with early coordination recommended to align with regional water plans and environmental safeguards. The applying permiting regulations are the following:

1. Decreto Legislativo Regional No. 33/2008/M.
2. Decreto Legislativo Regional No. 25/2017/M.
3. Portuguese national water law: Lei n.º 58/2005, de 29 de Dezembro (Legal Water Regime and Water Resources), sets out the public domain of water, need for authorisation of uses, abstraction and groundwater.

5 Stakeholder mapping and analysis

The chapter presents the stakeholder landscape for Macaronesia as it has been identified by five related organisations. The research made use of statistically structured survey questionnaires. The survey provided an overview of stakeholder dynamics, challenges, and opportunities for the GENESIS project. The tabulated data gathered highlighted the importance of tailored engagement strategies to address regional needs, particularly in areas like La Palma and the Azores. By addressing barriers such as lack of awareness, financial limitations, and mistrust while leveraging opportunities like awareness campaigns and capacity-building workshops, the project can foster stronger stakeholder collaboration and achieve its goals in water governance and NBS.

On the subsequent sub-chapter, a comprehensive overview of the survey results is provided supported by statistical inference.

5.1 Respondent information

Seventeen survey responses were received from organisations related to water management, research, and regional governance. Below is a summary of the respondent organisation information:

1. Asociación para la Investigación de la Macaronesia (AIM),
2. Instituto Tecnológico de Canarias, S.A.,
3. Horta City Hall,
4. La Palma Research Centre,
5. University Madeira.

5.2 Stakeholder identification and ranking

Respondents identified a wide range of stakeholders, including government agencies, local communities, NGOs, businesses, farmers, and research institutions. More specifically:

1. Centro Iniciativas y Turismo Insular de La Palma (CIT Insular La Palma).
2. Canaragua Concesiones SA.
3. Parque Nacional Caldera de Taburiente / National Park of Caldera Taburiente.
4. Comunidad para la Distribución y Riego en las vertientes Norte y Oeste de La Palma (Canopalma).
5. Consejo Insular de Aguas de La Palma / Island Water Council of La Palma.
6. Comunidad de Aguas Los Loros.
7. Comunidad de Aguas Los Girineldos.
8. IPMA.
9. Aguas de Telde.
10. University of the Azores (UAç).

11. Reserva de la Biosfera de La Palma.
12. Consejo Insular de Aguas de Gran Canaria.
13. Cabildo Insular / Consejo Insular de Aguas de La Palma.

Table 5.1 provides an indicative breakdown of the stakeholder types, their roles, and their attitudes toward NBS.

Table 5.1: Stakeholder types, their roles, and their attitudes toward NBS.

Type	Organisations	Influence	Attitude towards NBS
Government Agencies	Consejo Insular de Aguas de La Palma, Dirección General de Aguas	Key figure, Active figure	Supportive, Sceptical
Local Communities	Comunidad de Aguas Tenisca, Heredamiento de Las Haciendas de Argual y Tazacorte	Active figure, Peripheral figure	Supportive, Sceptical
NGOs	Asociación Aguas para La Palma,	Peripheral figure	Supportive, Skeptical
Businesses/Industry	Canaragua Concesiones SA, Asociación de Productores de Plátano de Canarias	Peripheral figure	Skeptical
Farmers/Agriculture	Plataforma Agraria Libre de Canarias, Asociación Palmera de Agricultores	Active figure	Skeptical
Research/Academia	University of Madeira, University of the Azores	Key figure, Peripheral figure	Supportive

Based on the aforementioned, the stakeholders were ranked according to their influence over water governance decisions and their interest and engagement in water governance, as presented in Table 5.2.

Table 5.2: Stakeholder ranking.

Stakeholder Name	Influence Rank (1-5)	Interest Rank (1-5)
Consejo Insular de Aguas de La Palma	5	5
Instituto Tecnológico de Canarias, S.A.	5	5
Canaragua Concesiones SA	4	4
Ayuntamiento de Tazacorte	4	4
Asociación Aguas para La Palma	3	4
Comunidad de Aguas Tenisca	4	4
Environmental groups (e.g., WWF, SEO Birdlife)	1	3

Government agencies like the Consejo Insular de Aguas de La Palma consistently rank high in both influence and interest. Communities such as Comunidad de Aguas Tenisca are presented with significant influence and engagement.

5.3 Barriers and opportunities for stakeholder engagement

Respondents identified several barriers that could hinder stakeholder involvement in GENESIS activities. The barriers were categorised, and their frequencies were recorded. Table 5.3 provides the frequency distribution.

Table 5.3: Barriers to stakeholder engagement frequency response distribution.

Barrier	Frequency
Lack of awareness or understanding	High (6 responses)
Institutional or political barriers	High (6 responses)
Financial or resource limitations	High (6 responses)
Social or cultural resistance	Medium (4 responses)
Lack of stakeholder interest	Medium (4 responses)
Communication barriers	High (6 responses)

The most significant barriers to stakeholder engagement are related to awareness, institutional challenges, financial constraints, and communication issues. Less Frequent Barriers are social/cultural resistance and lack of stakeholder interest (each mentioned 4 times).

To overcome these barriers, the respondents suggested several predefined opportunities with Table 5.4 providing their frequency distribution.

Table 5.4: Opportunities for stakeholder engagement frequency response distribution.

Opportunity	Frequency Mentioned
Awareness campaigns	High (6 responses)
Capacity-building workshops	High (6 responses)
Financial incentives	High (6 responses)
Policy support	High (6 responses)
Demonstration projects	High (6 responses)

The most recommended opportunities are awareness campaigns, capacity-building workshops, financial incentives, policy support, and demonstration projects (each mentioned 6 times).

To leverage the opportunities, the respondents ranked a series of predefined engagement

methods, Table 5.5 provides the frequency distribution for methods that scored higher than three responses.

Table 5.5: Effective engagement methods frequency response distribution.

Method	Ranking (Top 3)
Personal meetings and interviews	Highest (6 responses)
Focus groups and roundtable discussions	Higher (5 responses)
Professional workshops and technical seminars	High (4 responses)
Public consultations and community events	Medium (3 responses)

Personal meetings and interviews are the most effective methods for engaging stakeholders, followed by focus groups and workshops.

5.4 Key statistical insights

On average, stakeholders have a high level of interest (mean = 4.0) and moderate influence (mean = 3.5) in water governance decisions. There is no significant difference between influence and interest ranks. The most significant barriers are a lack of awareness, institutional barriers, financial limitations, and communication barriers. Awareness campaigns, capacity-building workshops, financial incentives, policy support, and demonstration projects are the most recommended opportunities. Personal meetings and interviews are the most effective method for engaging stakeholders.

Inferential statistics using hypothesis testing allow for predictions or inferences about the population based on the sample data. To identify whether there is a significant difference between the mean influence rank and the mean interest rank of stakeholders, a Null Hypothesis (H_o) was formulated along the lines of no significant difference exists between the mean influence rank and the mean interest rank. The Alternative Hypothesis (H_1) then is that a significant difference exists between the mean influence rank and the mean interest rank. Since the same stakeholders are ranked for both influence and interest, a paired t-test was deployed for the analysis. The results were as follows:

- Mean Difference: 4.0−3.5=0.54.0−3.5=0.5.
- Standard Deviation of Differences: 0.89.
- Sample Size (n): 6.
- t-statistic: 1.36.
- Critical t-value (α = 0.05, df = 5): 2.57.

Since 1.36<2.571.36<2.57, the null hypothesis cannot be rejected and thus there is no significant difference between the mean influence rank and the mean interest rank of stakeholders.

Thus, stakeholders who are interested in water-governance activities hold proportional influence in decision-making processes. Stakeholder engagement efforts are balanced by aligning motivation with decision leverage. Therefore, strategies like capacity-building and

awareness campaigns can target both influence and interest groups simultaneously, without a large risk of mismatch.

For testing whether there is a relationship between the barriers and opportunities mentioned by respondents, the Null Hypothesis (H_0) formulates on the grounds that there is no relationship between barriers and opportunities. The Alternative Hypothesis (H_1), indicates that there is a relationship between barriers and opportunities. To test for this statistical inference, the Chi-Square test of independence (χ^2), a non-parametric method, is used to determine whether the two categorical variables are related or independent of each other. The Chi-Square test is a distribution-free method that does not rely on normal data distribution and is appropriate when the data is ordinal or categorical. Table 5.6 provides the chi-square parameters for this statistical inference.

Table 5.6: Chi-square test parameters.

Barrier	Awareness Campaigns	Capacity-Building	Financial Incentives	Policy Support	Demonstration Projects
Lack of awareness or understanding	6	6	6	6	6
Institutional or political barriers	6	6	6	6	6
Financial or resource	6	6	6	6	6
Social or cultural resistance	4	4	4	4	4
Lack of stakeholder	4	4	4	4	4
Communication barriers	6	6	6	6	6

The results are as follows:

- Chi-Square Statistic: 0 (since all frequencies are proportional).
- Critical Chi-Square Value ($\alpha = 0.05$, $df = 5$): 11.07.
- Since $0<11.070<11.07$, the null hypothesis cannot be rejected.

There is no significant relationship between the barriers and opportunities mentioned by respondents. The responses are uniform and all barriers appear to motivate similar opportunity proposals. Thus, stakeholders adopt the view of multi-purpose solutions as beneficial across different constraint types. Awareness, policy support, and demonstration projects are perceived as universal enablers, not tied to a single problem domain. Caution should be taken regarding the aforementioned, as the statistical sample is limited and not necessarily representative. Thus, the analysis is indicative and should be interpreted as such.

5.5 Recommendations for stakeholder engagement

To enhance stakeholder engagement and achieve the objectives of the GENESIS project in water governance and NBS, it is crucial to address common barriers such as limited awareness, institutional constraints, financial limitations, and communication difficulties. Effective interventions should include targeted awareness campaigns, capacity-building workshops, and financial incentives. Personal meetings and interviews, complemented by focus groups and workshops, are recommended as the most effective methods for engaging stakeholders.

Respondents also provided valuable suggestions for further improvement, such as. incorporating more stakeholders from the tourism sector and financially influential government agencies, and expanding stakeholder engagement to include more private and public companies, as well as NGOs. The importance of involving key stakeholders from project partners and water-focused communities was emphasised.

The prominent role of government agencies was highlighted, particularly those dealing with water and agriculture, which consistently demonstrate significant influence and interest. Additionally, local communities and water associations are essential stakeholders, especially in areas like La Palma, characterised by private water ownership. However, engagement efforts face challenges due to the traditionally conservative nature of the water sector, coupled with social polarisation and mistrust.

Based on these insights, it is suggested to prioritise targeted awareness and educational initiatives to improve understanding of NBS. Capacity-building activities are essential for strengthening collaboration among stakeholders. Additionally, advocating for policy support is critical to addressing institutional barriers and promoting sustainable water governance. Promoting inclusive stakeholder participation is recommended to effectively address the diverse interests and concerns within communities. The survey results highlight specific regional challenges and dynamics, particularly in La Palma and the Azores. Table 5.7 provides a summary of key regional insights.

Table 5.7: Survey highlights.

Region	Key Insights
La Palma, Canary Islands	Water resources are mostly privately owned (90%). Agriculture is the largest consumer of water. Mistrust between stakeholders and lack of digitalisation.
Azores	Strong influence of government agencies. Financial and resource limitations are key barriers.
Madeira	Government agencies are highly supportive. Lack of stakeholder interest and communication barriers.

The absence of statistically significant differences or relationships does not indicate a lack of insight. On the contrary, it shows consensus and convergence in stakeholder perspectives. Stakeholders across regions perceive the same enabling conditions (awareness, funding, governance clarity) as universally accepted for NBS. This convergence simplifies policy design and enables a unified communication and

engagement strategy that can be applied Macaronesia-wide, with only minor contextual adjustments per island.

6 Understanding public perception via interviews

The study analysis from the previous section has allowed to design and implement structured interviews in five islands: Gran Canaria, La Palma, Faial, El Hierro, and Cabo Verde. These structured interviews were conceived along the lines of identifying the stakeholders and in general, the public perception of nature-based solutions (NBS) especially on what they mean, their functions, the obstacles and the opportunities they represent. These are represented further below where the interview data is analysed and subsequently delineated on a strength, weakness, opportunities and threats (SWOT) analysis. This was used to synthesise broader strategic insights for NBS implementation, supported by stakeholder clustering based on institutional type.

Consequently, the data was synthesised and extracted into meaningful information that can be further deployed in the project but also in the future for similar uses. It should be noted that the interviews are not strongly representative of the whole population due to the small sample as well as the lack of stratification and randomness. Nonetheless, the results are indicative and still useful for research purposes.

To overcome the aforementioned, each interview was systematically reviewed and coded according to recurring thematic categories such as stakeholder understanding of NBS, perceived benefits and limitations, governance challenges, public awareness, and willingness to implement. A comparative matrix was developed to facilitate cross-case analysis, allowing for identification of convergence and divergence across stakeholder groups such as regional vs. local government, academic vs. community actors. Descriptive statistics were applied to the coded data to assess frequency and alignment of thematic responses.

6.1 Cape Verde

The interview qualitative assessment for Cape Verde drew on semi-structured interviews with three senior stakeholders from Cabo Verde. The interviews focused on NBS for water storage and resource management under the GENESIS project. Participants represented research, agricultural extension, and environmental policy institutions. Table 6.1 provides data on the participating organisations.

Table 6.1: List of participants for Cape Verde.

Organisation/Sector	Type
Agriculture	Water/agriculture governance
Environmental/Water Resource Sector	Institutional representative
National Institute for Agricultural Research	Research Institute

6.1.1 Interview data analysis

All three interviewees displayed a well-informed and practical understanding of NBS, particularly in relation to soil restoration, water infiltration, forestry, and traditional techniques. All participants had extensive experience on reforestation, contouring, and soil water retention. There are small-scale nature-based solutions in Cabo Verde, but their implementation is still limited to select programmes.

The participants provided a good understanding on the benefits of the NBS with focus on:

- Improved water retention and aquifer recharge,
- Agricultural resilience and food security,
- Reinforced community engagement and ecological restoration.

The main challenges and the related specific issues identified were:

- Climate extremes (droughts, erratic rainfall),
- Technical and financial limitations,
- Weak inter-institutional coordination in implementation.

The public acceptance is generally high due to past efforts in public outreach and visible success stories. Nonetheless, structural barriers (access, education, funding) persist. The following actions were identified as areas for improvement:

- Capacity building and extension services,
- Integration of traditional knowledge with new technologies,
- Investment in communication strategies and digital outreach,

The following areas are suggested as suitable areas for nature-based solutions:

- Santiago Island (e.g. Ribeira Seca, Ribeira Principal),
- Boa Vista and Maio for groundwater recharge potential,
- Need for soil and hydrological mapping.

There is a strong willingness to participate in future projects and recognition of the need for co-financing, co-design, and interdisciplinary collaboration. Despite a general consensus among the three interviewed stakeholders on the potential of NBS for water storage and land resilience, a number of conditional factors and points of divergence were noted in their responses.

Firstly, although public awareness of environmental issues is relatively high in Cabo Verde, especially regarding drought, desertification, and soil degradation, the specific concept of NBS remains technical and abstract for much of the general population. All stakeholders emphasised that the public tends to understand and support solutions when they are tangible and visibly linked to immediate needs, such as water access, agriculture, or flood prevention. Thus, acceptance of NBS is conditional on perceived relevance to people's daily livelihoods and on clear demonstration of benefits.

Secondly, divergent experiences with NBS implementation were observed. The successful application of small-scale reforestation and contour bunding in certain areas, with measurable improvements in water infiltration and vegetation recovery, was highlighted. However, such successes were not uniformly observed across other islands or administrative units. This reflects a broader institutional asymmetry—some sectors have

stronger technical capacity, political support, or access to international projects than others.

Moreover, conditionality arises in inter-institutional collaboration. While coordination is recognised as vital, real integration between ministries, municipalities, and research institutes remains partial. It was pointed out that even when strategic alignment exists at the policy level, implementation is often hindered by gaps in mandates, funding flows, and operational timing. This leads to fragmented efforts and limits the scaling of successful practices.

Finally, all three stakeholders identified a need to adapt messaging and outreach to the socio-cultural context of Cabo Verde. Successful projects tend to be those that embed local knowledge, work with trusted community actors, and avoid top-down imposition. Thus, trust, co-ownership, and social learning are essential for effective engagement and the long-term adoption of NBS. The chart bar in Figure 6.1 depicts the frequency of responses against the themes of the questions asked.

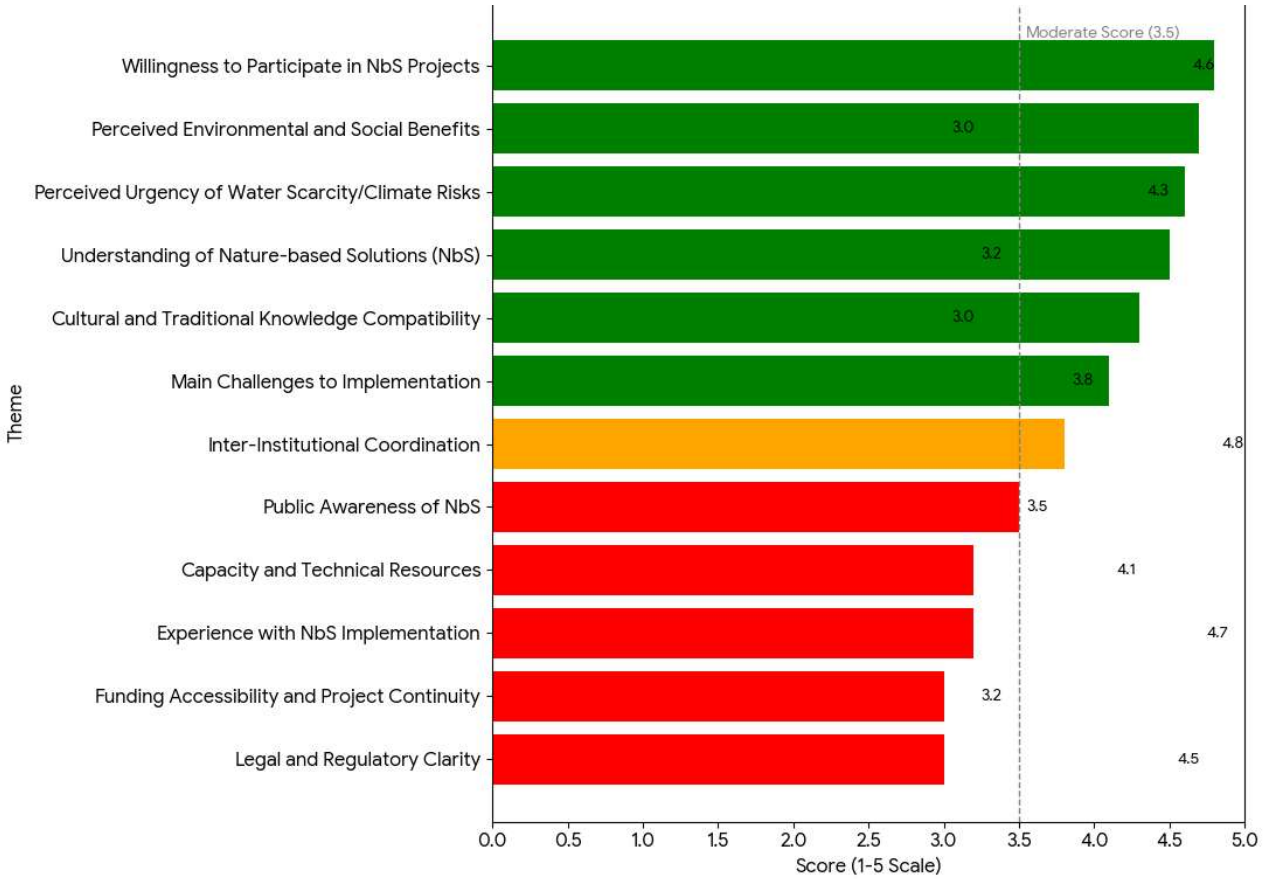

Figure 6.1: Frequence of responses against the question themes.

6.1.2 SWOT analysis for NBS for water storage

The SWOT analysis is based on the same semi-structured interviews with the three key stakeholders from the academia and the farming community on the island of Cape Verde.

The strengths are summarised as follows:

- Scientific and institutional awareness,
- Positive track record with local practices,

- Community engagement traditions,
- Alignment with national sustainability goals.

Stakeholders demonstrated a high level of understanding of NBS principles and their ecological applications, particularly in soil conservation, forestry, and water infiltration. Several pilot efforts in contouring, reforestation, and traditional water retention systems have shown measurable environmental improvements. Past successes in reforestation and rural development programmes have created a cultural base for participatory approaches. NBS concepts align well with existing strategies on land restoration, drought resilience, and rural development.

The weaknesses are summarised as follows:

- Fragmented implementation capacity,
- Limited technical personnel and infrastructure,
- Policy and coordination gaps,
- Inconsistent access to financing.

While awareness exists, there is a lack of consistent, well-funded programmes that translate strategy into scalable actions. Shortages in trained staff, hydrological data, and monitoring tools restrict the scope of action. Cross-sectoral collaboration remains weak, with overlapping mandates and operational inefficiencies. Local authorities and community organisations often struggle to access or manage international funding.

The opportunities are summarised as follows:

- Use of traditional knowledge,
- Research-led innovation,
- Integration with climate adaptation frameworks,
- Targeted communication and education.

Cabo Verde's long-standing practices in dryland agriculture, terracing, and forest recovery offer culturally appropriate entry points for NBS expansion. Research institutions can lead in testing, documenting, and scaling NBS interventions adapted to specific islands and microclimates. NBS can be aligned with national adaptation plans and attract international funding (e.g. Green Climate Fund). Enhanced outreach, especially in schools and through rural extension programmes, could increase public support and behavioural change.

The threats are summarised as follows:

- Climate extremes and unpredictability,
- Dependency on donor-driven initiatives,
- Political turnover and policy inconsistency,
- Public fatigue or skepticism.

Increasing droughts and temperature variability may challenge the efficacy and durability of NBS if not well-adapted to future scenarios. Over-reliance on short-term external funding can undermine sustainability if local ownership is not strengthened. Shifting priorities between administrations may delay or disrupt ongoing NBS programmes. Communities may become disillusioned if interventions fail to produce immediate, visible results, especially in high-stress rural environments. From the aforementioned, it is suggested that Cabo Verde is well-positioned conceptually and institutionally to implement NBS, but requires targeted investment in capacity building, governance reform,

and long-term monitoring systems to move from successful pilot experiences to broader territorial impact.

Willingness and perceived benefits are very high, confirming strong institutional and personal support for NBS. Understanding of NBS is also strong, showing effective knowledge transfer among professionals. Public awareness and practical experience are moderate, suggesting areas for targeted capacity building and outreach. Challenges are acknowledged as significant, but not seen as insurmountable.

6.1.3 Interview data synthesis and derived information

Each stakeholder demonstrated a strong conceptual understanding of NBS, particularly as they relate to soil and water conservation, forestry, and land restoration. This level of familiarity suggests that the foundational knowledge needed to design and implement NBS is already well established among key technical actors in the country. However, the conclusions from a statistical and general prospective should be viewed on a qualitative and indicative basis due to the small number of participants.

There is a clear willingness across institutions to engage in NBS projects, especially through pilot interventions that can demonstrate tangible results. However, while enthusiasm is high, practical experience remains moderate. NBS have been integrated in some sectors—especially agriculture and reforestation but often in a fragmented or small-scale manner. This reflects a broader challenge: translating awareness into large-scale implementation will require coordinated effort across ministries, technical agencies, and community organizations.

Stakeholders consistently emphasised the perceived benefits of NBS. These include increased water retention, improved food security, erosion control, and climate adaptation, issues that are all deeply relevant in Cabo Verde's dry and ecologically fragile environment. Importantly, these benefits are not seen as abstract or theoretical; rather, they are rooted in the country's lived experience with drought, land degradation, and the need for sustainable agricultural models.

Despite these strengths, significant implementation challenges persist. Among them are gaps in technical capacity, limited financial resources, and insufficient inter-institutional coordination. Yet, none of these were framed by stakeholders as insurmountable obstacles. Instead, they were viewed as areas where targeted investment and governance reform could yield real gains.

Public awareness was judged to be moderate, with some positive momentum from past reforestation and environmental projects. Nevertheless, the stakeholders noted that public understanding of NBS concepts, beyond general environmental awareness, remains uneven. Effective communication, tailored to local contexts and incorporating schools, farmers, and community leaders, is therefore essential to strengthen engagement.

One of the most promising insights from the interviews is the alignment between NBS and Cabo Verde's traditional knowledge systems. Practices such as terracing, dry farming, and soil bunding not only remain culturally relevant, but also technically compatible with modern NBS frameworks. This intersection between tradition and innovation presents a powerful opportunity to design interventions that are both ecologically effective and socially accepted.

Lastly, the stakeholders emphasised the importance of trust and visibility. For NBS to succeed in Cabo Verde, they must be embedded in local realities, show early results, and involve communities from the beginning. Conditional acceptance of NBS, especially in

under-resourced rural areas, will hinge on their ability to deliver direct, visible benefits. The interviews suggest that the most effective path forward will involve small-scale, well-documented pilot projects that can be scaled over time through shared learning, strategic financing, and multi-level governance.

6.2 El Hierro

The data analysis employed a qualitative content inference approach, drawing from three semi-structured interview transcripts with key stakeholders involved in renewable energy, primary sector and public administration in El Hierro. It should be noted that the small sample of interviews does not constitute any statistical significance and thus is not representative of the El Hierro community but is indicative and still valuable. Table 6.2: List of participantsprovides data on the participating organizations.

Table 6.2: List of participants for El Hierro.

Sector	Role
Renewable Energy	Ops. & Maintenance, La Gorona del
Dairy livestock sector	Manager
Public Administration	Head of Environmental Impact, Gov.

All interviewees had mid- to high-level responsibilities within their organisations and demonstrated varying degrees of technical familiarity with NBS.

6.2.1 Interview data analysis

All participants understood NBS as nature-derived or ecosystem-based approaches to managing water, though the level of technical specificity varied. Public officials articulated a clear ecological systems perspective, while others associated NBS more with “natural or low-impact” interventions.

Only one Governmental stakeholder reported direct experience with NBS, mostly through environmental compensatory reforestation. The energy and livestock representatives lacked hands-on experience but expressed strong interest in future pilot projects.

The participants provided a good understanding of the benefits of the NBS with a focus on:

- Long-term sustainability,
- Landscape conservation (key for tourism),
- Reduction in external dependency (especially in the primary sector),
- Compatibility with traditional systems.

The main challenges and the related specific issues are:

- Lack of public and political understanding,

- Excessive bureaucracy and institutional fragmentation,
- Limited local pilot examples,
- Cultural bias towards “hard” infrastructure.

Public awareness was considered low, with some noting a historical disconnection between current and past generations regarding water scarcity challenges. Political ideologies and a lack of environmental education were also identified as factors limiting public understanding.

Several strategic pathways were proposed to improve the enabling environment for NBS in El Hierro:

- Environmental education and citizen participation,
- Demonstration projects,
- Governance simplification,
- Inclusion of traditional knowledge (cisterns, Garoé system),
- Intersectoral working groups.

The following areas are suggested as suitable areas for NBS:

- El Pinar (rural and water-scarce area),
- Pozo de los Padrones recharge zone (aquifer-dependent area),
- Reforestation zones in higher altitudes.

All stakeholders expressed clear interest in NBS pilot projects. Agreement exists around:

- The need for governance reform,
- Local stakeholder engagement,
- NBS complements traditional practices.

There is divergence in terms of perceived readiness; some participants see the population as supportive in theory, while others highlight cultural resistance and lack of agency. Conditional acceptance is likely to depend on visibility of results, regulatory simplification, and trusted local leadership. The chart bar in Figure 6.2 depicts the response against the themes of the questions asked.

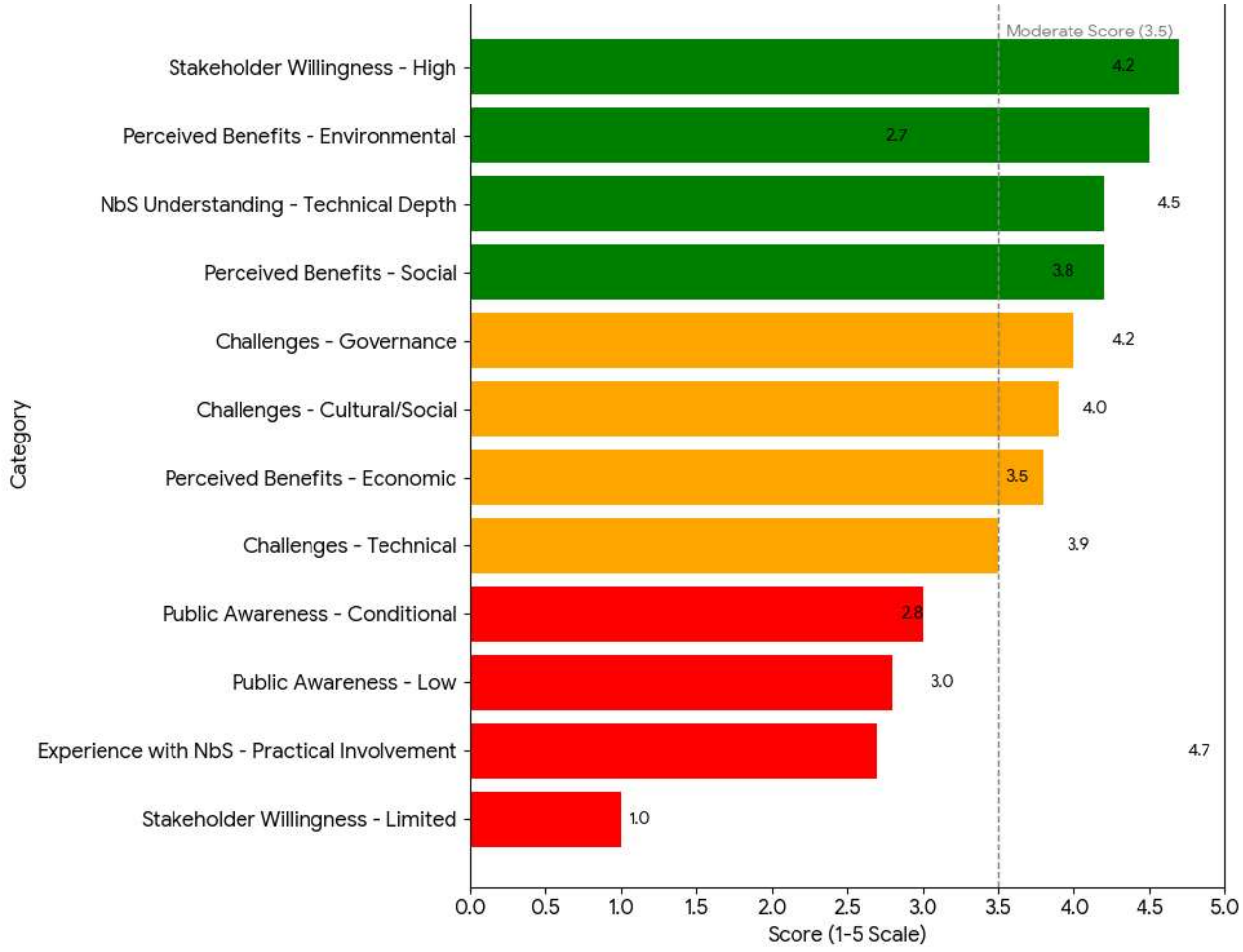

Figure 6.2: Frequency of responses against the question themes.

This matrix shows that conceptual and strategic support for NBS is high in El Hierro, but experience and public readiness lag behind**.** The strongest areas of alignment are in perceived benefits and stakeholder willingness, while public engagement and institutional readiness remain areas for improvement.

6.2.2 SWOT analysis for NBS for water storage

The SWOT analysis was based on the same semi-structured interviews that took place with the three key stakeholders from the regional government, the energy sector and the farming community.

The strengths are summarised as follows:

- High conceptual awareness,
- Cross-sectoral willingness,
- Alignment with El Hierro's identity,
- Landscape conservation as a shared value.

Stakeholders, especially from the public administration, demonstrated a strong understanding of NBS principles and their ecological functions. All interviewees expressed strong support for future NBS pilot projects, regardless of their sector (energy, livestock, government). The island's ecological character and emphasis on sustainability (e.g., 100%

renewable energy ambition) make NBS a culturally and strategically compatible solution. NBS were viewed as beneficial not only for water but also for preserving El Hierro's unique environment, essential for tourism and identity.

The weaknesses are summarised as follows:

- Low public awareness and engagement,
- Institutional fragmentation and bureaucratic barriers,
- Limited technical implementation experience,
- Cultural preference for "grey infrastructure".

Stakeholders noted a general lack of understanding or interest from the broader population, especially among younger generations unfamiliar with historical water scarcity. Current governance structures create delays and confusion in implementing cross-sectoral projects like NBS. Apart from isolated reforestation efforts, the island lacks concrete, visible examples of NBS in practice. There is still a bias toward engineered, large-scale water infrastructure among both officials and the public.

The opportunities are summarised as follows:

- Pilot project development in high-need áreas,
- Reviving traditional water systems,
- Environmental education and public outreach,
- Integration with El Hierro's sustainability branding.

Sites such as El Pinar and aquifer recharge zones (e.g., Pozo de los Padrones) offer natural testbeds for NBS. Local cisterns, terraces, and the Garoé tree's historical legacy provide culturally grounded narratives for NBS promotion. Stakeholders see value in integrating NBS concepts into schools, public campaigns, and participatory planning. NBS can reinforce the island's existing positioning as a model for eco-resilience and green innovation.

The threats are summarised as follows:

- Policy inconsistency and political short-termism,
- Dependence on external funding and expertise,
- Climate extremes,
- Community skepticism and institutional mistrust.

Shifts in leadership may deprioritise long-term solutions like NBS in favor of more visible interventions. Local implementation capacity is limited, and the island depends heavily on regional and EU-level funding. Increased frequency of droughts and variable rainfall patterns may challenge the long-term reliability of some NBS strategies. Without transparency and co-ownership, new projects may face resistance or indifference from locals.

The SWOT analysis reveals that El Hierro holds strong potential for NBS, particularly due to its sustainability culture and stakeholder readiness. However, institutional coordination, technical capacity, and public engagement must be strengthened to move from discourse to demonstrable impact.

6.2.3 Interview data synthesis and derived information

The stakeholder interviews in El Hierro reflect a landscape of high conceptual support for NBS, but also reveal practical limitations and contextual constraints that must be addressed to move toward implementation.

Across the three interviews, all stakeholders recognised the long-term environmental and socio-economic value of NBS for water storage, aquifer recharge, and ecological preservation. These solutions were seen as aligning with El Hierro's broader vision of sustainability, particularly in connection with its renewable energy model and emphasis on local resilience. Notably, interviewees from both the energy and primary sectors expressed strong willingness to participate in NBS initiatives, even in the absence of prior experience.

Still, the island presents clear implementation challenges. Among them, public awareness of NBS remains limited, and stakeholders noted a generational gap in understanding the value of nature-based water management. This is compounded by a cultural tendency to prioritise engineered, "grey" infrastructure solutions over ecological or hybrid alternatives. The interviews suggest that this perception gap may hinder community support unless NBS are visibly demonstrated and connected to local history and identity.

Institutional barriers also persist. Stakeholders pointed to bureaucratic fragmentation, limited inter-agency coordination, and delays in decision-making as common obstacles to NBS implementation. These issues, while not unique to El Hierro, are particularly acute in small island contexts where resources and staff are limited.

Despite these constraints, there are clear opportunities for localised pilot projects, especially in areas such as El Pinar or Pozo de los Padrones, where water scarcity is critical and terrain is suitable for infiltration or reforestation interventions. Traditional water practices and historical references (e.g., the Garoé tree) offer culturally grounded entry points to foster community engagement and trust.

Overall, the analysis suggests that El Hierro is well-positioned to benefit from NBS, but targeted efforts are required to build public understanding, strengthen governance coordination, and demonstrate early successes. Environmental education, participatory design, and the revival of local ecological knowledge will be essential to overcoming skepticism and ensuring long-term support. With adequate planning and intersectoral commitment, NBS can play a vital role in reinforcing El Hierro's ecological integrity and climate resilience.

6.3 Faial

The data analysis employed a qualitative content inference approach, drawing from six semi-structured interview transcripts with key stakeholders involved in water governance, environmental management, and community practices in Faial. Table 6.3 provides data on the participating organisations.

Table 6.3: List of participants for Faial.

Organisation/Sector	Type
Community-based Agriculture	Community Actor

University of the Azores	Academic
Faial Municipal Government	Local Government
Cabildo / Island Council	Island Authority
Regional Environmental Agency	Regional Authority

6.3.1 Interview data analysis

All stakeholders demonstrated clear understanding of NBS concepts, linking them both to traditional ecological practices (e.g., fog harvesting, soil conservation) and contemporary environmental planning. Practical implementation remains limited but emerging. The participants provided a good understating on the benefits of the NBS with focus on:

- Environmental: runoff reduction, aquifer recharge, erosion control.
- Economic: long-term cost savings and enhanced agricultural resilience.
- Social: improved landscape management and food security.

The main challenges and the related specific issues are:

- Governance fragmentation and lack of cross-agency coordination,
- Technical capacity gaps and insufficient funding at the local level,
- Weak inclusion of NBS in formal policy instruments.

Public awareness is generally low, but not resistant. The acceptance improves when projects are visible and locally tailored. Importantly, communication and education are central to raising awareness.

The following actions were identified as areas for improvement:

- Demonstration projects with measurable outcomes,
- Participatory governance platforms,
- Integration of traditional practices with scientific methods,
- Capacity-building for municipal and community actors.

The following areas are suggested as suitable areas for nature based solutions:

- Ravines and mid-elevation slopes prone to erosion and flooding,
- Degraded lands previously used for agriculture or water collection,
- Sites with historic significance for water retention or fog collection.

All stakeholders indicated strong interest in pilot projects and alignment on environmental and cultural benefits of NBS. There is agreement on the need for co-design, policy support, and institutional reform.

While there is broad consensus on the conceptual value of NBS, several conditional factors influence the degree to which different stakeholders perceive their feasibility and urgency. Notably, institutional actors (regional and island governments) tend to frame NBS through the lens of strategic alignment with EU environmental directives and long-term sustainability goals. In contrast, local stakeholders, including the municipality and the

farming community, emphasise the practical applicability, immediate landscape needs, and resource constraints affecting implementation.

One key area of divergence is institutional readiness. Regional and island-level representatives generally express optimism about policy direction but acknowledge bureaucratic complexity and delayed operationalisation. Meanwhile, municipal staff report limited technical capacity, and the farmer cites inadequate access to incentives or field-level support for integrating NBS into daily practices.

Public awareness was unanimously described as low, yet all respondents highlighted that this does not equate to resistance. Instead, acceptance was framed as

conditionally dependent on several factors:

- Visibility of outcomes,
- Cultural resonance,
- Communication and education.

Communities are more likely to trust NBS when they can observe tangible results, such as water retention, greening, or reduced flooding. Framing NBS within traditional or ancestral practices (e.g., fog harvesting, mulching, or terrace farming) enhances their perceived legitimacy. Awareness improves when schools, local media, or pilot projects actively disseminate knowledge about NBS. While stakeholders are broadly aligned in principle, their operational capacities, institutional mandates, and perceptions of public readiness diverge in ways that must be carefully addressed in both design and policy formulation. Public trust and understanding are not static, but rather evolve through co-design, demonstration, and community-centered engagement.

The chart bar in Figure 6.3 depicts the response against the themes of the questions asked.

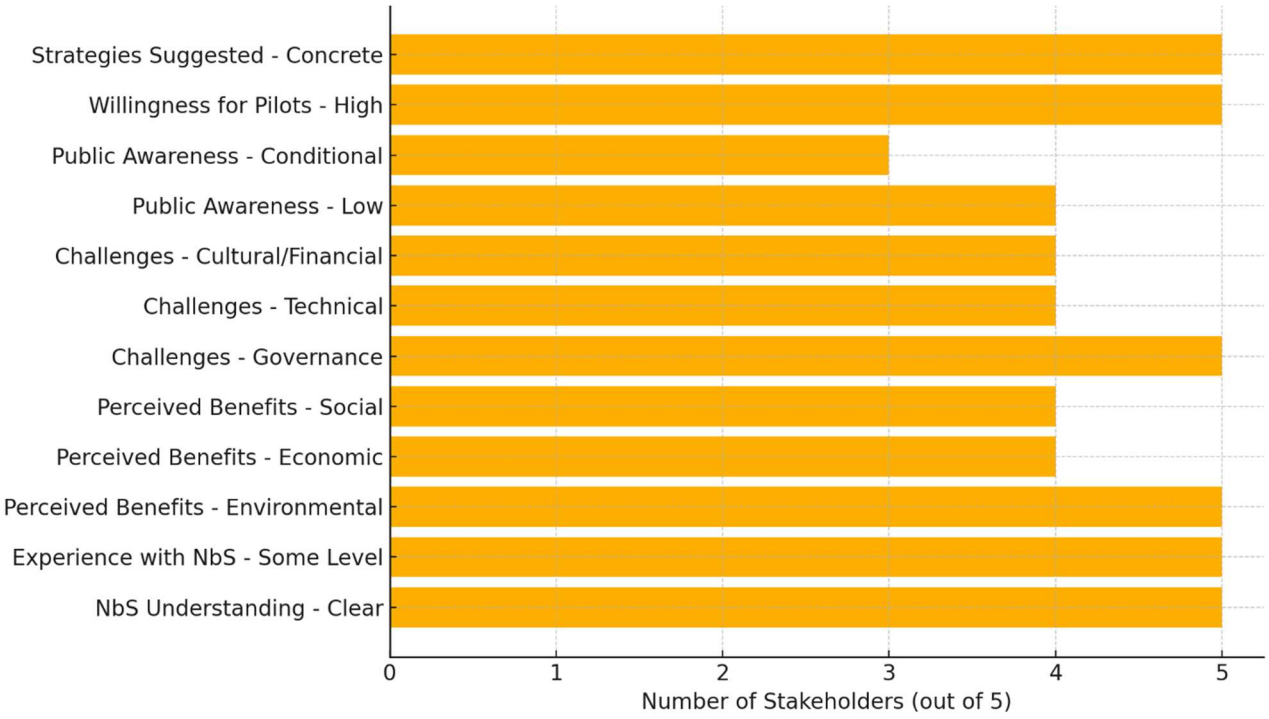

Figure 6.3: Frequence of stakeholder groups responses against the question themes.

6.3.2 SWOT analysis for NBS for water storage

The SWOT analysis is based on semi-structured interviews with the six key stakeholders from the regional government, island authority, local government, academia, and the farming community on the island of Faial.

The strengths are summarised as follows:

- Shared environmental consensus,
- Strong multi-sectoral willingness,
- Cultural and scientific complementarity.

All stakeholders recognised the environmental importance of NBS, particularly for mitigating surface runoff, improving soil moisture retention, and promoting aquifer recharge. Several also noted the alignment of NBS with local landscape rehabilitation goals and long-standing ecological practices. All six stakeholders expressed a clear willingness to support or engage in pilot or demonstration projects. This included institutional actors, scientific experts, and community-based practitioners. The farming community linked NBS to ancestral land management techniques, while academic and governmental stakeholders emphasised ecological engineering, water reuse, and circular economy principles. This convergence presents a solid foundation for interdisciplinary implementation.

The weaknesses are summarised as follows :

- Institutional fragmentation,
- Technical and capacity limitations,
- Public visibility and understanding,
- Policy mainstreaming lag.

As in other island contexts, governance responsibilities are split across administrative levels without adequate coordination. Local governments expressed difficulty in accessing technical resources without island or regional support. Municipal actors and community stakeholders highlighted a lack of technical staff, hydrological data, and dedicated funding for nature-based interventions. Awareness of NBS remains low among the general population. While not opposed in principle, the public remains sceptical due to the lack of visible, tangible results from previous ecological interventions. Despite policy alignment with EU adaptation strategies, there remains limited integration of NBS into existing land-use regulations and environmental planning instruments.

The opportunities are summarised as follows:

- Pilot project development,
- Reviving traditional water culture,
- Research–policy–community collaboration,
- Education and outreach.

Stakeholders identified specific zones in mid-elevation ravines and degraded agricultural terraces as high-potential sites for NBS trials, especially where hydrological stress and erosion risks are high. Practices such as fog harvesting, dry farming terraces, and mulch-based soil conditioning were highlighted as culturally resonant strategies that can be modernised through NBS frameworks. The University of the Azores and local technical services were both identified as key enablers in facilitating knowledge transfer, capacity

building, and co-design. There is strong potential for raising public awareness through school curricula, demonstration plots, and citizen science projects linked to water monitoring and land restoration.

The threats are summarised as follows:

- Political short-termism,
- Funding competition and economic uncertainty,
- Policy–practice disconnect,
- Risk of symbolic action.

Without proper impact assessment and visibility, there is a danger that NBS may be treated as experimental or symbolic rather than functional tools in long-term water planning. NBS projects face competition from traditional infrastructure solutions for limited public funding, particularly in fiscally constrained municipalities. Regional strategies often cite NBS in general terms, but do not provide clear regulatory or operational mandates to municipalities or island governments for on-the-ground implementation.

NBS are widely regarded by stakeholders in Faial as a viable and contextually relevant response to water storage and landscape degradation challenges. There is high willingness to engage in pilot projects, especially those that combine traditional knowledge with modern ecological planning. However, institutional bottlenecks, fragmented governance, and low public familiarity with NBS remain significant hurdles. To ensure successful uptake and scalability, it is essential to prioritise demonstration projects that offer visible and measurable benefits, facilitate community participation, and are supported by policy alignment and capacity-building initiatives. In Faial, the integration of traditional ecological practices with formalised NBS design offers a unique opportunity to build resilient, socially accepted water management strategies aligned with EU climate goals.

6.3.3 Interview data synthesis and derived information

The assessment of stakeholder perspectives in Faial reveals a highly favourable climate for the conceptual adoption of NBS, coupled with an emerging yet incomplete institutional framework for their implementation. All five stakeholder groups, spanning the farming community, academia, municipal government, island authority, and regional environmental administration, demonstrate a shared understanding of NBS, rooted both in ancestral land stewardship practices and contemporary ecological planning.

There is universal understanding across stakeholders to support pilot projects, and a general alignment around the environmental, economic, and social benefits of NBS. Key themes such as aquifer recharge, runoff reduction, flood control, and land rehabilitation emerged consistently, indicating a high degree of thematic convergence. This provides a solid basis for consensus-driven planning and co-designed implementation.

On the same note, this conceptual alignment is constrained by governance fragmentation, particularly between municipal and regional levels. Stakeholders cite significant capacity gaps, with municipalities lacking the technical staff, financial resources, and data necessary to lead NBS initiatives independently. Similarly, regional policy actors often frame NBS in strategic or programmematic terms without translating that discourse into tangible, localised planning instruments or funding channels.

Public awareness, while not resistant, remains low. NBS are not yet part of the public imagination or everyday conversation. Acceptance is conditional upon visibility, familiarity,

and demonstrated effectiveness**.** The lack of local showcase projects contributes to perceptions of NBS as abstract or experimental.

Despite these barriers, Faial possesses several advantages. The island's traditional ecological knowledge, including fog harvesting, soil conditioning, and terracing, offers a culturally grounded pathway to adapt NBS for modern use. Additionally, the presence of academic institutions, existing climate policy frameworks, and high stakeholder motivation creates fertile ground for action.

To move from interest to implementation, four strategic actions are proposed:

- Develop locally co-designed pilot projects in high-priority zones with visible hydrological stress,
- Strengthen multi-level coordination mechanisms between regional, island, and municipal governments,
- Mainstream NBS into environmental planning and regulatory instruments, including funding eligibility frameworks,
- Invest in public education and participatory engagement**,** leveraging schools, demonstration sites, and traditional narratives.

In conclusion, Faial shows strong potential to become a model island territory for the deployment of NBS in water management—provided that institutional alignment, technical capacity, and public legitimacy are actively fostered. The opportunity lies not merely in environmental restoration but in building a resilient, locally anchored water governance paradigm for the climate challenges ahead.

6.4 Gran Canaria

The data analysis employed a qualitative content inference approach, drawing from eight semi-structured interview transcripts with key stakeholders involved in water governance, environmental management, and community practices in Gran Canaria. Table 6.4 provides data on the participating organisations.

provides data on the participating organisations.

Table 6.4: List of participants for Gran Canaria.

Organisation/Sector	Type
Government of Canary Islands (Coastal Dept.)	Regional Public Sector
Cabildo de Gran Canaria (Environment Area)	Island Authority

Insular Water Council (CIAGC)	Island Authority
Telde City Council	Local Government
University of Las Palmas de Gran Canaria (ULPGC)	Academic
Environmental Consultant (Private Sector)	Technical Expert / Consultant
Local Farmer (Traditional Irrigator)	Private / Community
Environmental NGO	Civil Society / NGO

6.4.1 Interview data analysis

Stakeholders across all sectors shared a consistent understanding of NBS as interventions that work with ecological processes to address water and climate challenges. Definitions ranged from technical interpretations, such as infiltration basins, aquifer recharge, and fog harvesting to practical framings that emphasised low-impact, sustainable practices rooted in traditional knowledge. Academic and institutional actors often referenced EU-aligned definitions, while local practitioners and civil society emphasised landscape familiarity and cost-effectiveness.

Overall, stakeholders reported a moderate level of experience with NBS implementation. Public sector entities such as the Cabildo de Gran Canaria and academic institutions have engaged in pilot projects, water reuse initiatives, and experimental fog harvesting.

Municipalities and farmers reported smaller-scale interventions, like erosion control, gully reforestation, and use of volcanic gravel for infiltration. NGOs and consultants contributed to community-based NBS trials, particularly in educational and co-design contexts.

The participants provided a good understating on the benefits of the NBS with focus on:

- Water Resilience: Increased infiltration and aquifer recharge, reduced runoff.
- Ecosystem Restoration: Biodiversity support, erosion control, and fire prevention.
- Energy Efficiency: Reduced reliance on high-cost solutions like desalination.
- Knowledge Revitalization: Strengthening of local traditions in water and land stewardship.
- Social Co-benefits: Empowerment of local actors and improved inter-sectoral collaboration.

The main challenges and the related specific issues identified during the interview are summarised in Table 6.5.

Table 6.5: Challenges and specific issues.

Challenge Category	Specific Issues

Governance	Fragmented institutions, inconsistent policies, weak cross-level
Bureaucratic	Administrative complexity, delayed permits, overly cautious
Cultural/Social	Skepticism, short-termism, weak engagement with traditional
Technical	Lack of data, monitoring systems, and trained personnel

Stakeholders largely agreed that public awareness of NBS remains low, particularly outside academic and policy circles. Rural representation showed greater receptiveness, especially when included early in the planning process. Trust-building relies heavily on demonstration projects that show visible benefits. NGOs and municipalities emphasised the need for clear communication and context-sensitive messaging. Thus, several strategic pathways were proposed to improve the enabling environment for NBS in Gran Canaria:

- Participatory planning involving farmers, schools, and water user associations,
- Pilot demonstrations in areas with visible water stress or erosion,
- Education and awareness campaigns tailored to different demographic groups,
- Inter-agency coordination mechanisms, especially between island and regional authorities,
- Learning from analogues, particularly other Mediterranean or outermost regions with similar constraints.

The following areas are suggested as suitable areas for nature based solutions:

- Mid-altitude agricultural zones (e.g., Telde, La Gavia, San Roque),
- Salt marshes and ravines (e.g., Barranco de Tirajana, Salinetas),
- Northern basins with high runoff and flood risk.

There is strong alignment and willingness to collaborate among institutions, technical experts, and community actors. Most stakeholders indicated readiness to support or participate in pilot projects. Environmental benefits and governance challenges were universally acknowledged. Social co-benefits and technical challenges were widely discussed, with several actors stressing the importance of capacity-building and peer learning. A few constraints were noted, including staffing limitations, budget restrictions, and unclear regulatory pathways.

While there was general convergence on the benefits of NBS, some differences in emphasis were evident. Economic benefits (e.g., water savings, energy reduction) were emphasised more by farmers and municipal actors than by academics. Cultural skepticism was highlighted by NGOs and consultants, particularly in urban contexts. Several stakeholders noted that acceptability is conditional on effective outreach and early engagement. Pilot projects were widely viewed as a key entry point to build trust and showcase tangible outcomes. Only a small number of actors cited institutional overload or legal ambiguity as critical barriers, though these issues remain latent risks.

The chart bar in Figure 6.4 depicts the response against the themes of the questions asked.

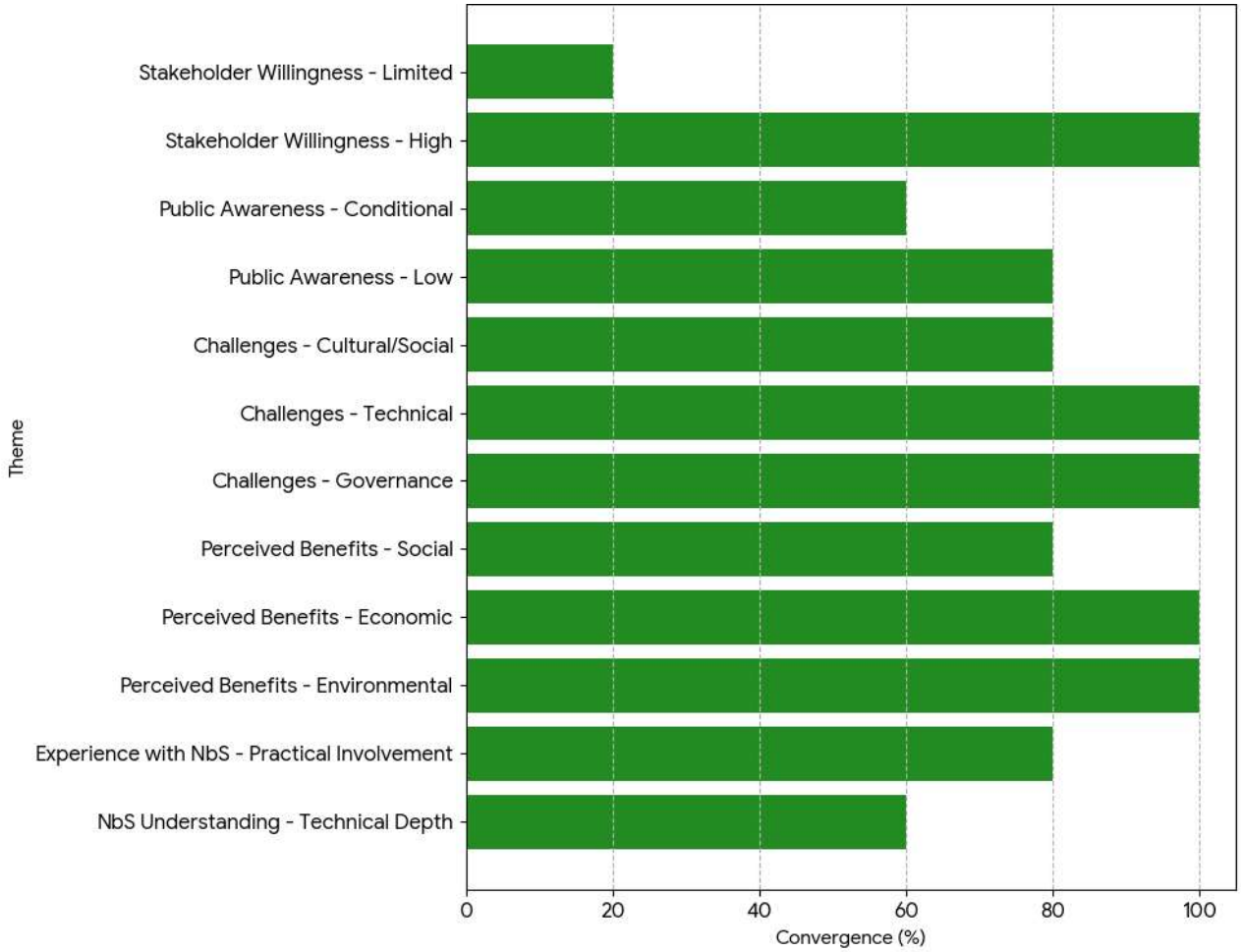

Figure 6.4: Frequence of responses against the question themes.

6.4.2 SWOT analysis for NBS for water storage

The swot analysis was base on the semi-structured interviews with eight key stakeholders from regional government, island authorities, local government, academia, consultancy and the farming community.

The strengths are summarised as follows:

- Broad institutional awareness and willingness,
- Alignment with local practices,
- Academic and technical capacity,
- Multi-level support for pilots.

All stakeholders across public, academic, private, and civil society sectors demonstrated strong conceptual understanding and a clear interest in participating in NBS efforts. Traditional water and land-use methods (e.g., stone terraces, volcanic gravel infiltration, fog harvesting) closely align with NBS principles, providing a cultural and technical foundation for adoption. Institutions such as the University of Las Palmas (ULPGC) and Cabildo de Gran Canaria provide scientific expertise, access to EU frameworks, and experience in pilot projects. Pilot projects were positively endorsed by municipalities, consultants, NGOs, and water authorities, showing cross-sectoral momentum for implementation.

The weaknesses are summarised as follows:

- Low public awareness,
- Limited practical experience,
- Legal and institutional ambiguity,
- Bureaucratic barriers.

The general population remains largely unaware of NBS concepts and benefits. Without targeted communication, public buy-in may be slow. Unclear jurisdiction over land, water, and project ownership leads to delays and friction, particularly between island-level and regional authorities. Despite strong interest, many institutions and actors have limited hands-on implementation of NBS, particularly in the water storage domain. Administrative delays, conservative technical standards, and procurement challenges hamper flexibility and innovation in NBS design.

The opportunities are summarised as follows:

- Pilot projects in targeted zones,
- EU policy and funding synergies,
- Revival of traditional knowledge,
- Multi-stakeholder co-design.

Areas such as Telde, La Gavia, Barranco de Tirajana, and Salinetas offer ecological and social readiness for demonstration projects. Gran Canaria, as an EU outermost region, can align NBS with biodiversity, climate adaptation, and circular economy goals to access funding streams. Reconnecting with heritage water practices can strengthen community identity, improve environmental stewardship, and reinforce the legitimacy of NBS. Cross-sectoral collaboration between academic institutions, NGOs, municipalities, and user associations creates space for innovative, participatory planning.

The threats are summarised as follows:

- Political and planning inertia,
- Resource constraints in smaller entities,
- Climate change outpacing action,
- Cultural skepticism in urban áreas.

Short-term political cycles and reluctance to shift from ”hard” infrastructure (e.g., dams, desalination) may delay or derail NBS integration. Municipalities and water user associations may lack technical personnel or financial capacity to initiate or maintain NBS without external support. Increasing droughts, fires, and erosion may accelerate water scarcity faster than current institutional response capabilities allow. Perception of NBS as less effective or “too experimental” persists among some technical departments and urban constituencies.

Environmental benefits, governance obstacles, and stakeholder willingness offer a solid base for coordinated action. Divergence appears mostly in technical familiarity, perceptions of public awareness, and emphasis on economic framing—these reflect the institutional roles rather than ideological disagreement. The thematic alignment is strong enough to justify integrated, cross-sectoral NBS planning—with targeted capacity-building for underrepresented dimensions (e.g., public engagement, monitoring skills).

6.4.3 Interview data synthesis and derived information

NBS are increasingly recognised in Gran Canaria's water management discourse, yet they remain peripheral to mainstream planning and implementation. All stakeholders interviewed were able to articulate a clear and contextually relevant definition of NBS, framing them as ecological or hybrid interventions that enhance natural processes to deliver water-related services. However, this conceptual familiarity has not yet translated into widespread operational uptake. Only a minority of actors particularly in academia and select government departments reported direct experience with NBS projects. This indicates that while NBS have achieved discursive legitimacy, they have not yet become the default solution; they are still seen as experimental, supplementary, or appropriate only in specific scenarios.

The island appears to be in a transitional phase: moving from theoretical endorsement of NBS to initial phases of operational integration. This shift is supported by a growing ecosystem of interest from academic institutions and municipalities to NGOs and farmers but is held back by several entrenched barriers.

Foremost among these is cross-level institutional fragmentation. Governance challenges were the only theme unanimously mentioned by all stakeholders, underscoring their systemic nature. Fragmentation manifests through unclear mandates, overlapping competences, uncoordinated policies, poor data sharing, and weak vertical coordination across regional, island, and municipal authorities. Importantly, these challenges are not rooted in technological limitations but in institutional design and culture. Without deliberate governance reform and improved cross-agency collaboration, even technically viable NBS may remain stalled.

Public awareness and acceptance, while low, are not insurmountable obstacles. Several stakeholders described public knowledge as "concealed" latent but activatable. Strategic outreach, particularly through tangible pilot projects, cultural references to traditional practices (e.g., fog harvesting, terraces), and participatory co-design processes, are seen as highly effective pathways for building social legitimacy. There is evidence of a mobilisation threshold: once reached through focused engagement, public support for NBS could expand rapidly.

Pilot projects are broadly supported but must be designed with strategic intent. Stakeholders warned against symbolic or overly academic pilots that fail to resonate with real community needs. The most impactful demonstrations would focus on highly visible and socially relevant problems, such as flood-prone urban ravines or degraded agricultural areas and should be developed through interdisciplinary teams involving ecologists, engineers, local authorities, and residents. Effective pilots should also incorporate robust monitoring systems to evaluate cost-effectiveness, ecological performance, and social acceptance. The aim is not just technical validation but policy influence and institutional learning.

Academic institutions, notably the University of Las Palmas (ULPGC), emerged as key governance brokers. They are positioned to bridge the gaps between under-resourced government bodies, landowners with practical knowledge, and the general public seeking credible information. ULPGC and similar institutions can provide scientific rigour, facilitate dialogue, and anchor multi-stakeholder processes essential for scaling NBS across diverse landscapes.

Gran Canaria presents high-potential biophysical zones that are especially suitable for NBS. Ravines, mid-altitude agricultural terraces, and degraded aquifers were frequently cited as priority areas. These zones not only align with ecological vulnerabilities, such as erosion,

flash flooding, and soil degradation but also overlap with socio-economic needs, especially in communities dependent on agriculture or facing water scarcity. Strategic interventions in these areas could yield high ecological and social returns on investment.

The policy and political landscape is currently favourable for mainstreaming NBS. Several stakeholders referenced the Ecoisla 2030 strategy, the EU Nature Restoration Law, and national adaptation plans as converging drivers. These frameworks present a unique window of opportunity between 2025 and 2030, during which NBS could be institutionalised through EU co-financing, climate mandates, and integrated regional planning. However, this window is time-sensitive. If missed, there is a real risk that NBS will remain marginal innovations rather than being embedded as the standard in water and land governance.

6.5 La Palma

This section synthesises findings from 17 semi-structured interviews conducted with diverse stakeholders across La Palma, including agricultural extension agents, municipal representatives, academic researchers, irrigation communities, environmental NGOs, civil protection authorities, and private consultants. The goal was to assess the social acceptability, perceived feasibility, and institutional landscape for implementing NBS for water storage.

The stakeholder group consulted for this study represents a diverse cross-section of institutions, sectors, and professional profiles involved in water management, land use, environmental protection, and civil infrastructure in La Palma. This diversity was intentional, ensuring that perspectives were gathered from those who influence, implement, and are directly affected by NBS for water storage.

Participants included representatives from public administration, ranging from regional water authorities (e.g., Dirección General de Aguas) to municipal governments (e.g., Ayuntamiento de Los Llanos de Aridane), as well as technical officers from the Island Council (Cabildo de La Palma). These actors are central to regulation, planning, and permitting processes. Irrigation communities and water user groups, such as Comunidad de Regantes de Los Sauces and Unión de Canales. These stakeholders manage key water infrastructure on the island and are responsible for distributing and maintaining water across agricultural areas. Academic and technical experts, including university researchers and independent consultants, provided insight into hydrology, environmental engineering, and ecological restoration, offering a scientific basis for the feasibility of NBS. Environmental and agricultural associations, such as ASPA (a farmers' association) and La Centinela (an environmental NGO), contributed grassroots knowledge and reflected the concerns of land users and conservation advocates. Civil protection and emergency response personnel, such as the director of the island's emergency services, provided a risk-based perspective, emphasising the need for flood mitigation and fire resilience, both of which intersect with NBS objectives.

This stakeholder cohort reflects a multi-dimensional governance context, with actors operating at local, island, and regional levels. While their institutional mandates differ, stakeholders consistently emphasised the importance of inter-sectoral coordination,

community engagement, and evidence-based planning. The combination of governance authority, local expertise, and territorial knowledge represented in this group provided a robust foundation for assessing both the opportunities and constraints associated with NBS in La Palma.

6.5.1 Interview data analysis

Most stakeholders demonstrated moderate to high familiarity with NBS concepts, associating them with infiltration galleries, aquifer recharge, reforestation, and fog catchers. Academic and institutional respondents (e.g., ULPGC, CIALP) showed particularly deep and systemic knowledge.

Practical engagement varied. Irrigation communities and water engineers had direct experience with infiltration and channel design. Others, such as municipal or regional stakeholders, acknowledged conceptual knowledge but limited hands-on implementation.

Stakeholders across La Palma expressed a strong and consistent appreciation for the multi-dimensional benefits of NBS, emphasising their potential to address both ecological and socio-economic challenges associated with water scarcity, climate change, and land degradation. The majority rated the perceived benefits very highly (scores of 4 or 5), underscoring a convergence of understanding despite differences in institutional roles or technical backgrounds.

Many stakeholders, particularly engineers, water managers, and academics, identified NBS as a key mechanism for restoring hydrological balance. Measures such as infiltration galleries, natural retention zones, and vegetated buffers were found to be effective in enhancing groundwater levels. NBS were widely viewed as capable of reducing surface runoff, especially in high-rainfall events. This was considered critical in erosion-prone zones and areas affected by past wildfires. Reforestation and ecosystem regeneration were identified as co-benefits of NBS, which could enhance soil health, support native species, and increase landscape resilience.

While some stakeholders expressed concerns over upfront costs, many highlighted the long-term savings of NBS due to reduced infrastructure maintenance and lower energy demands (e.g. gravity-fed systems). Others noted opportunities for eco-tourism, agroecological branding, and rural employment. Agricultural actors, particularly those from irrigation communities, highlighted the role of NBS in stabilising water supply, thereby reducing production risk and enhancing crop resilience during drought.

Several respondents, including those from local municipalities and NGOs, emphasised the role of NBS in reconnecting communities with traditional ecological knowledge, such as fog harvesting and dryland terrace agriculture. Educational and participatory value was also noted. NBS were seen as tools to engage schools, citizens, and farmers in learning about climate adaptation and water management. In rural areas, stakeholders suggested NBS could revitalise abandoned landscapes and attract younger populations back into land stewardship roles.

A few high-level stakeholders described NBS as instruments that can decrease political dependency on large-scale grey infrastructure and provide more adaptive, decentralised solutions. There was also recognition that NBS align well with EU funding priorities and climate policy frameworks, offering leverage for public investment.

Despite strong conceptual support for NBS, stakeholders consistently highlighted significant and recurring obstacles, both institutional and practical, that hinder the

widespread implementation of these solutions on the island. These challenges fall into five interrelated domains.

One of the most commonly cited barriers is the lack of coordination across governance levels, particularly between municipalities, the Island Water Council (CIALP), regional authorities, and irrigation communities. Stakeholders noted that there is no centralised leadership or shared platform for cross-sector NBS planning. Decision-making is siloed, with limited communication between land-use planning and water policy institutions. The current governance model results in overlaps, inefficiencies, and missed funding opportunities. Several stakeholders also mentioned inflexibility in institutional structures, where procedural norms and slow bureaucracy limit the ability to trial innovative, adaptive approaches like NBS.

Numerous interviewees flagged the Canary Islands Water Law as outdated or overly restrictive, making it challenging to recognise and support certain types of NBS legally. Specific issues included the lack of formal recognition of infiltration systems or fog catchers as valid infrastructure. Regulatory focus on conventional engineering (e.g., pipelines, reservoirs) creates barriers for funding or approval of NBS alternatives. Absence of clear criteria or guidelines for evaluating NBS performance or compliance. Stakeholders emphasised the need for legal reform or reinterpretation, particularly to incorporate NBS into technical plans and public procurement rules.

While many actors were conceptually aligned with NBS, several pointed to limited technical capacity to implement, monitor, or maintain them. This includes a shortage of trained personnel at the municipal and community levels with expertise in hydrology, ecology, or engineering. Lack of baseline data on aquifer levels, soil infiltration rates, and watershed behaviour makes it difficult to design effective NBS. Weak integration of GIS tools, environmental modelling, and performance metrics into public-sector planning. This challenge was especially pronounced in smaller municipalities and among volunteer-based irrigation communities.

The economic feasibility of NBS was a recurring concern. Several stakeholders described the perception of NBS as costly or risky investments, particularly the absence of dedicated funding streams for NBS projects at the local level. There was a difficulty in quantifying return on investment, especially for longer-term ecological gains. It was also noted that dependence on EU or pilot project funding creates short timeframes and undermines sustainability. In addition, irrigation stakeholders mentioned that profit-driven water trading models sometimes conflict with the collective stewardship approach embedded in NBS.

Although most stakeholders expressed personal interest in NBS, they noted hesitancy among other actors, especially the sceptical farming sector, which has been shaped by decades of conventional infrastructure and private water ownership norms. Generation gaps in understanding ecological principles, with older farmers often prioritising reliability and tradition over innovation. The general public is unfamiliar with this concept, resulting in a lack of bottom-up pressure to promote NBS in political agendas. Some interviewees also identified past failures of public participation, including tokenistic consultations or underfunded awareness campaigns, as reasons for persistent distrust.

Stakeholders across institutional, technical, and civil society roles uniformly described public awareness of NBS as low to very low, despite growing concern about climate impacts and water scarcity. However, this limited awareness is not necessarily equivalent to resistance. Instead, acceptance was often described as conditional, latent, or unevenly distributed across sectors and demographics.

Most respondents noted that the general population is unfamiliar with the term "NBS" and its practical implications. When the concept is understood, it is often confused with reforestation, gardening, or beautification rather than being recognised as an integrated water management strategy. Both academics and local authorities cited terminological barriers. The term "NBS" is viewed as abstract, technical, or imported, lacking resonance in public discourse unless linked to tangible practices.

Urban and younger populations were generally described as disconnected from land and water management issues, particularly where daily water access is not perceived as precarious. In contrast, rural residents, especially older generations, may understand the functions of NBS (e.g., infiltration, fog capture) but do not use formal terminology. Their acceptance is higher when NBS are linked to ancestral knowledge or traditional farming techniques. A few stakeholders noted that public interest tends to spike only during crises, such as droughts, water cuts, or after wildfires, but quickly dissipates without sustained communication efforts.

Despite low baseline awareness, nearly all stakeholders emphasised that public acceptance is possible and even likely if certain conditions are met. When people can see functioning NBS (e.g. infiltration zones, green buffers), they are more likely to trust them. Acceptance improves when NBS are framed in terms of water security, cost savings, or local heritage, rather than abstract ecological principles. Stakeholders widely agreed that pilot sites are essential for public buy-in. Success stories with measurable outcomes were seen as critical to changing perceptions.

Municipalities and NGOs reported a lack of structured outreach, with NBS rarely featured in school curricula, local media, or citizen science programmes. Participatory tools, such as workshops, co-design meetings, or community mapping, are underutilised. One respondent noted, "People are not against NBS; they are simply not part of the conversation." There is an opportunity to leverage existing local associations, including agricultural cooperatives and water boards, as channels for communication, education, and pilot testing.

Several stakeholders proposed actionable strategies to enhance public engagement by integrating NBS into climate education campaigns, targeting schools and local events. Using visual media (e.g. short videos, signage at demonstration sites) to explain how NBS work. Building co-benefits into messaging e.g. linking NBS to flood prevention, green jobs, or local food security. Promoting cultural continuity, emphasising how modern NBS reconnect with historic land-use practices such as terrace farming, fog harvesting, or natural mulching.

Stakeholders across La Palma agree that NBS are both needed and promising but to succeed, they must be embedded within clear governance structures, supportive policies, visible projects, public engagement, and long-term financing. The strategies proposed reflect a strong desire not only to innovate, but to rebuild trust**,** revive traditional knowledge, and realign institutions for sustainable water management in the face of escalating climate stress. Stakeholders across the public, private, technical, and civil society sectors proposed a wide range of strategies to overcome current implementation barriers and improve the acceptance, visibility, and long-term viability of NBS in La Palma. While challenges were recognised as complex and multi-level, most respondents expressed a proactive willingness to collaborate on solutions, particularly those that offer tangible outcomes, participatory processes, and local relevance. These strategies can be grouped into six key areas, which are analysed further below.

Nearly all stakeholders emphasised the need to transition from discourse to practice by developing concrete, visible pilot projects. These are seen as critical for:

1. Demonstrating technical feasibility in La Palma's specific environmental conditions,
2. Building public trust and institutional confidence through real-world results,
3. Providing data for monitoring impacts (e.g. infiltration rates, recharge levels),
4. Offering learning laboratories for replication elsewhere on the island.

Several suggested starting with mid-elevation zones, ravines, and fire-affected areas, where environmental conditions are most favourable and local needs are greatest. Stakeholders across governance levels called for:

1. Greater vertical coordination between municipalities, the Island Water Council (CIALP), and the regional water authority,
2. Clear assignment of institutional roles and responsibilities for NBS planning, funding, and maintenance,
3. Interdepartmental task forces or "NBS units" that integrate environmental planning, civil protection, and water management,
4. Mainstreaming NBS into planning instruments, such as hydrological plans, zoning ordinances, and risk management frameworks.

One interviewee suggested the creation of a "multisectoral NBS coordination platform" to ensure alignment across stakeholders.

Legal and procedural reforms were frequently mentioned, particularly adapting the Canary Islands Water Law to recognise NBS as legitimate and fundable water infrastructure formally. Establishing technical standards and guidelines for NBS design, implementation, and evaluation, revising public procurement processes to accommodate non-traditional solutions, such as community-led or nature-based initiatives. Stakeholders also recommended aligning NBS policies with broader climate adaptation strategies and EU funding priorities.

To address low public familiarity and skepticism, stakeholders proposed educational campaigns that frame NBS in terms of water security, resilience, and cultural continuity. School-based programmes and partnerships with local educators to integrate NBS into curricula. Development of multimedia materials (e.g. videos, infographics, local case studies) explaining NBS benefits. Establishment of demonstration trails, signage, and visitor-friendly sites in public areas to make NBS visible and accessible. Use of local narratives and traditional practices to legitimise NBS (e.g. linking infiltration to ancestral land care).

Stakeholders from technical institutions and NGOs emphasised the need to educate municipal technicians and water managers in NBS design and monitoring. Promote peer learning exchanges between La Palma and other islands or EU territories with successful NBS cases. Develop open-access knowledge platforms to share maps, hydrological data, best practices, and cost-benefit analyses. Strengthen collaborations with academic institutions (e.g. ULPGC, ULL, University of Azores) for applied research and student involvement.

A major barrier identified was the lack of dedicated and sustained funding. To address this, stakeholders proposed accessing EU climate adaptation funds (e.g., LIFE, Horizon, CAP) earmarked for NBS. Establish micro-financing schemes or public-private partnerships to reduce risk and incentivise local investment. Then include NBS as eligible infrastructure in disaster recovery funds (especially post-fire and post-flood scenarios), coupled with exploring agro-environmental subsidies tied to land stewardship, infiltration, and ecological practices. Some also proposed creating performance-based payment systems,

where actors maintaining NBS receive compensation based on environmental outcomes (e.g. infiltration volume, reduced erosion).

Stakeholders agree that site selection must be evidence-based, utilising hydrological data, land use patterns, and socio-political factors, while also being pragmatic and visible. Demonstrating success in even one site could help catalyse broader acceptance and scale-up across the island. Stakeholders identified several categories of suitable areas for NBS on La Palma, as provided in Table 6.6.

Table 6.6: Suitable areas for NBS.

Area type	Rationale
Mid-altitude recharge zones	Sufficient rainfall, terraces, fog exposure
Ravines and fire-affected slopes	High erosion risk, natural flow paths, urgency for
Abandoned terraces/farmland	Existing land shaping, low intervention cost, potential for reactivation
Areas with water gallery systems	Existing hydrological infrastructure, technical
Municipal/public lands	Easier access, political will, potential for
North/Northeast slopes	Higher rainfall, community readiness, and traditional ecological practices

All stakeholders expressed a high degree of willingness to engage with NBS for water storage and climate resilience. This readiness was consistent across institutional types, despite variations in technical capacity, past experience, and operational mandates.

Nearly all interviewees conveyed a proactive interest in participating in NBS initiatives. Many explicitly stated their openness to hosting pilot projects, contributing technical knowledge, or collaborating across sectors. For example, municipal authorities indicated they would be willing to allocate public land for demonstration projects, while irrigation communities expressed openness to testing infiltration systems if supported by scientific data and co-financing mechanisms. The Island Water Council (CIALP), through both technical and managerial representatives, signalled strong institutional support for integrating NBS into formal hydrological planning, provided that clear frameworks and resources are established.

A notable area of convergence among stakeholders was the understanding that NBS should not be positioned in opposition to grey infrastructure, but rather as a complementary strategy, particularly in the context of a changing climate, limited water availability, and mounting environmental stress. Stakeholders broadly agreed that NBS could enhance existing systems through recharge, runoff control, and ecological co-benefits, provided they are designed for local conditions and not treated as one-size-fits-all solutions.

Another consistent theme was the call for visible and practical demonstration. Stakeholders emphasised the importance of moving beyond theoretical discussions and implementing pilot projects that showcase feasibility, deliver measurable results, and

engage the local population. These projects are seen as essential tools not only for technical learning but for building public trust and political legitimacy.

The interviews also revealed a shared appreciation for the cultural and historical relevance of certain NBS practices. Several respondents noted that infiltration, terracing, fog harvesting, and mulching techniques have deep roots in La Palma's traditional water culture. There is consensus that NBS framed through this lens, as a revival and modernisation of ancestral knowledge, would resonate more strongly with rural communities and increase long-term buy-in.

Despite this overall alignment, stakeholders were careful to outline key conditions for their willingness to be realised in practice. These included the need for clear and equitable role definitions, adequate funding and technical assistance, transparency in monitoring and evaluation, and respect for the work already being done by local actors. Importantly, many expressed a desire for co-design processes that meaningfully involve them from the outset, rather than being consulted after decisions have already been made.

Although stakeholders in La Palma generally expressed support for the principles and goals of NBS, interviews revealed subtle divergences and important conditionalities that could shape how such solutions are implemented, communicated, and received across the island.

A key area of divergence lies in the institutional and sectoral framing of NBS. While public-sector actors, academics, and environmental NGOs often emphasised the long-term ecological and hydrological benefits, stakeholders from irrigation communities and the agricultural sector tended to prioritise practical performance, cost-efficiency, and direct economic returns. These different expectations reflect distinct value systems: one rooted in ecosystem services and sustainability, the other in resource control, reliability, and productivity. Importantly, this divergence does not indicate opposition, but rather different operational logics that must be reconciled during planning and design phases. Further divergence arises around perceived feasibility and technical confidence. Stakeholders with direct hydrological or engineering expertise were more likely to view NBS as viable under current conditions. At the same time, those with less exposure to applied projects expressed skepticism or uncertainty, often citing past failures, bureaucratic inertia, or limited institutional continuity. These factors create a climate in which support for NBS is contingent upon guarantees of technical rigour, demonstrable outcomes, and manageable administrative procedures.

Generational and cultural dynamics also emerged as conditional factors. Younger professionals in academia, NGOs, and regional governance were often more enthusiastic about NBS innovation, while some older stakeholders in the agricultural sector expressed nostalgia for conventional approaches and a preference for what they perceived as "proven" infrastructure. Nonetheless, several interviewees noted that framing NBS as an evolution of traditional practices, rather than a departure from them, helped bridge these generational gaps.

Crucially, the interviews revealed widespread concern about public awareness. Stakeholders across all profiles agreed that most of the population in La Palma remains unaware, mainly of NBS, both as a concept and as a practical tool. This lack of awareness is not always rooted in resistance, but often in disconnection from ecological processes and limited access to environmental education. The term "NBS" was perceived by several respondents as technical and inaccessible, with limited penetration into public discourse.

Stakeholders emphasised that public acceptance is not automatic. It is conditional on visibility, relevance, and engagement. When NBS are explained through concrete examples, such as infiltration zones, traditional terrace systems, or fog harvesting structures,

acceptance improves. On the same note, abstract language or top-down implementation can deepen skepticism. Participation, co-design, and culturally grounded communication were consistently identified as key to overcoming this awareness gap. The chart bar in Figure 6.5 depicts the response against the themes of the questions asked.

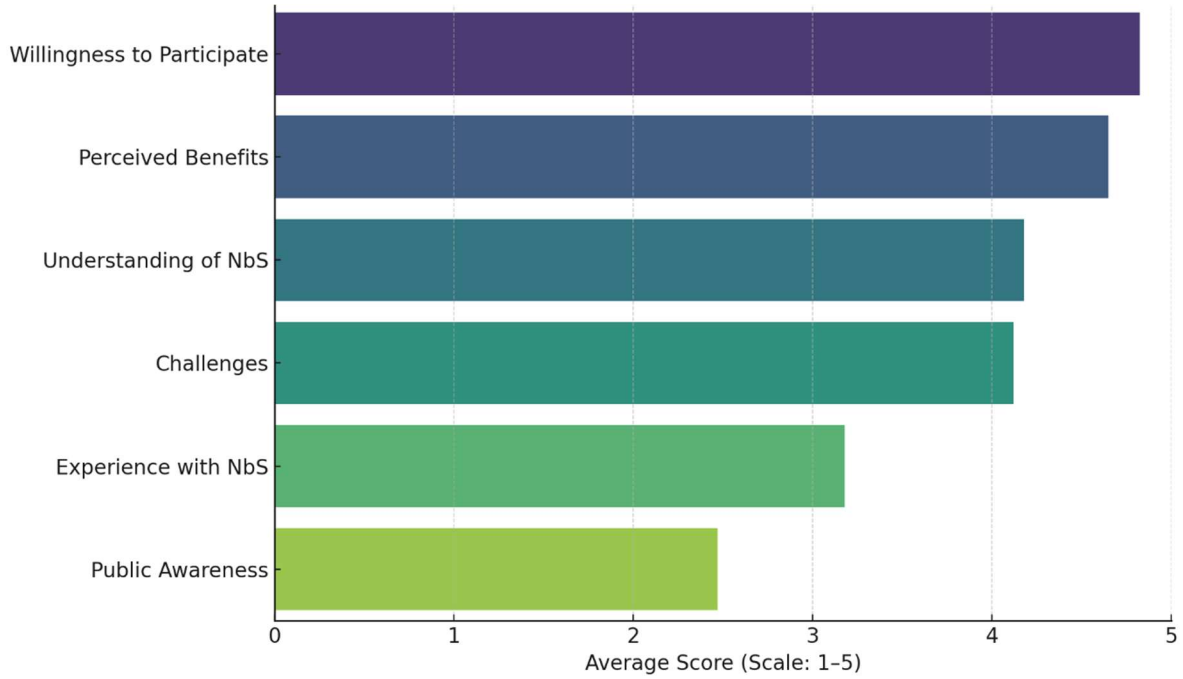

Figure 6.5: Frequency of responses against the question themes.

6.5.2 SWOT analysis for NBS for water storage

Below is the SWOT Analysis for the implementation of NBS for water storage in La Palma, developed based on qualitative coding and comparative synthesis of the 17 stakeholder interviews.

The strengths are summarised as follows:

1. High stakeholder willingness and interest,
2. Shared understanding of ecological value,
3. Alignment with traditional practices,
4. Interdisciplinary knowledge base.

Nearly all stakeholders across the public, academic, technical, and community sectors expressed readiness to participate in NBS initiatives, particularly in pilot projects. Strong conceptual agreement exists on the benefits of NBS in terms of aquifer recharge, erosion control, runoff reduction, and resilience to climate extremes. Stakeholders acknowledged the cultural familiarity of certain NBS (e.g., terraces, fog harvesting, mulching), which offered potential for public legitimacy and continuity. Presence of academic, technical, and environmental expertise across institutions (e.g. ULPGC, CIALP, irrigation communities) capable of supporting co-design.

The weaknesses are summarised as follows:

1. Low public awareness and engagement,

2. Institutional fragmentation,
3. Legal and regulatory gaps,
4. Limited technical implementation experience,
5. Data and monitoring deficiencies.

The general population is unfamiliar with NBS terminology or purpose; acceptance is conditional on demonstration and relevance. Lack of coordination among regional, island, and municipal authorities results in implementation gaps, duplicated efforts, and planning inefficiencies. The Canary Islands Water Law does not explicitly accommodate NBS as valid infrastructure; funding eligibility and procurement remain ambiguous. While conceptual understanding is strong, practical experience is limited. Most stakeholders have not yet worked directly with NBS technologies or planning. Inadequate baseline hydrological and soil data hinder performance modelling, site selection, and adaptive management of NBS interventions.

The opportunities are summarised as follows:

1. Pilot projects in suitable zones,
2. Policy alignment with EU climate priorities,
3. Public education and co-design potential,
4. Revival of traditional knowledge,
5. Academic–government partnerships.

High-potential areas identified (e.g. mid-altitude terraces, fire-affected slopes, ravines, public forests) where visible, low-risk pilot projects can be implemented. NBS aligns with the EU Green Deal, Horizon Europe, and LIFE funding programmes, enabling potential co-financing and capacity building opportunities. Strong potential for participatory processes, citizen science, and school-based environmental education programmes that raise awareness and trust. Reconnecting ecological innovation with ancestral land management practices could improve legitimacy and intergenerational transmission of stewardship. Existing research networks and institutions (e.g., universities, water engineers) offer technical support and credibility to municipal and island-led initiatives.

The threats are summarised as follows:

1. Policy and administrative inertia,
2. Perception of NBS as risky or unproven,
3. Under-resourced local institutions,
4. Accelerating climate impacts,
5. Fragmented land ownership.

The risk that implementation is delayed by bureaucratic processes, unclear mandates, or shifting political priorities after elections was a concern. Some stakeholders, especially in conventional agriculture or engineering sectors, remain cautious due to perceived unpredictability or lack of grey infrastructure guarantees. Smaller municipalities and irrigation communities may lack human and financial resources to initiate or maintain NBS without external support. The pace of ecosystem degradation, wildfires, and droughts may outstrip the institutional response capacity unless adaptation is prioritised urgently. Land tenure complexity, especially in terraced and abandoned agricultural areas, could pose a barrier to integrated planning and implementation.

La Palma offers a strong socio-political and ecological foundation for advancing NBS for water storage. The convergence of stakeholder willingness, ecological urgency, and cultural familiarity creates a promising landscape for pilot initiatives. However, success will depend on resolving legal ambiguities, closing capacity gaps, and translating conceptual alignment into operational, well-funded, and publicly supported action.

6.5.3 Interview data synthesis and derived information

The stakeholder consultation process in La Palma reveals a compelling landscape for advancing NBS for water storage. Across all 17 interviews, there is strong conceptual alignment on the potential of NBS to address pressing challenges such as aquifer depletion, soil erosion, and increasing climatic stress. Stakeholders from diverse sectors, including municipal governments, irrigation communities, regional authorities, academia, and NGOs, expressed a high degree of willingness to engage in future NBS initiatives. This willingness is most evident in the shared interest in pilot projects, co-design processes, and land-based demonstrations that build trust and generate tangible results.

Despite this widespread institutional readiness, a clear implementation gap remains. While most stakeholders understand the principles of NBS, very few have direct experience in applying them. This indicates the need to transition from conceptual discussion to practical demonstration, backed by robust technical guidance and effective monitoring systems. Experience is built through doing, starting small, learning from results, and scaling based on evidence.

A significant obstacle is the low level of public awareness. Interviews consistently indicated that the broader population has limited familiarity with NBS and often lacks the ecological literacy to understand their functions and benefits. Without deliberate efforts to increase visibility, relevance, and community participation, public support may remain weak or conditional. Strategies such as environmental education, culturally grounded communication, and citizen engagement are essential to closing this gap.

On the positive side, La Palma benefits from several key enabling conditions. There is strong alignment between traditional land-use practices and modern NBS approaches, particularly in the use of terraces, fog harvesting, and natural infiltration techniques. Academic institutions and local engineers possess relevant technical knowledge, and

multiple stakeholders are already exploring ways to collaborate more closely. These conditions present an opportunity to initiate a coordinated programme of pilot projects and institutional reform.

Nevertheless, structural and legal barriers must be addressed. Governance fragmentation, overlapping mandates, outdated regulatory frameworks, and a lack of dedicated funding continue to impede progress. The current water law does not formally recognise NBS as legitimate infrastructure, limiting access to public investment and EU funding mechanisms. Unless these challenges are resolved, the momentum behind NBS risks stalling at the level of discourse.

There is broad agreement across stakeholders on the benefits and importance of NBS, as reflected in the near-top scores for both Perceived Benefits and Willingness to Participate. The gap between Understanding and Experience suggests that while stakeholders conceptually support NBS, many have limited hands-on implementation exposure, highlighting the strategic need for pilot projects and capacity-building.

The high score for Challenges during the data analysis indicates that perceived institutional and operational barriers are widespread, particularly in the form of legal constraints, technical gaps, and fragmented governance. Public awareness remains critically low, representing the most significant weakness and a potential risk to social legitimacy, funding uptake, and long-term sustainability of NBS strategies.

Institutional willingness is not a bottleneck; instead, attention should focus on enabling conditions. A targeted sequence of small-scale, high-visibility pilot projects could convert high-level awareness into operational competency. Without improving societal understanding and visibility of NBS, support may remain isolated within expert circles

In light of this, the path forward must centre on inclusive, transparent, and collaborative approaches. Stakeholders consistently called for participatory planning, co-ownership of interventions, and equitable distribution of responsibilities. Rather than viewing NBS as external or imposed, successful implementation depends on framing them as a renewal of La Palma's ecological traditions rooted in local knowledge, adapted to present realities, and oriented toward future resilience.

6.6 Cross island comparative insights

Across all five islands, the interviews revealed a consistently high level of conceptual awareness of NBS among institutional and academic stakeholders. In most cases, interviewees demonstrated a clear understanding of NBS as ecosystem-based strategies that restore natural hydrological cycles, reduce runoff, enhance aquifer recharge, and support biodiversity. However, as it was expected, this depth of understanding tends to diminish at the community level, where public discourse on NBS remains minimal, and awareness is largely shaped by perceptions of conservation rather than water management. The latter has been shaped from many years of practice and it persists as the lack of communicating on that matter may be also minimal directly reflecting the awareness.

The strongest technical comprehension was found in Faial, Cabo Verde, and Gran Canaria, where stakeholders could articulate how NBS integrate with broader ecological and socio-economic systems.

Experience with the practical implementation of NBS, however, was generally limited. In most islands, tangible projects remain rare, small-scale, or small polit scale. While Cabo

Verde showed relatively more experience due to past reforestation and erosion control efforts, other regions such as La Palma, Faial, and El Hierro reported little experience for NBS projects. Gran Canaria stood out slightly by referencing pilot initiatives and renewed interest in traditional water management practices, but on the same note institutional support remains weak. Despite this lack of experience, there was widespread enthusiasm to initiate demonstration projects, particularly if they are locally led and grounded in familiar land-use systems.

The perceived benefits of NBS were widely acknowledged across all islands. Stakeholders consistently emphasised environmental gains, such as improved water infiltration, reduced soil erosion, and ecosystem restoration. In regions like El Hierro and Faial, there was a strong connection between NBS and local identity, with several participants highlighting how these solutions aligned with the islands' cultural and environmental ethos. In contrast, Cabo Verde and Gran Canaria placed greater emphasis on the strategic utility of NBS for long-term water security and agricultural resilience. Economic benefits, while acknowledged, were often viewed as secondary or long-term, with most stakeholders prioritizing environmental integrity and social stability. Again, the aforementioned are indicative and not necessarily reflecting the perception of the whole population.

Implementation remains constrained by a series of structural challenges. Governance fragmentation emerged as one of the most persistent obstacles across regions. Stakeholders in La Palma and Faial described complex bureaucratic landscapes in which responsibility for water, land, and planning is dispersed across multiple, often uncoordinated entities. Gran Canaria and Cabo Verde reported similar institutional overload and inertia, where overlapping mandates and rigid procedures obstruct timely and integrated action. Cultural resistance was another key theme, particularly in El Hierro and La Palma, where stakeholders noted a societal preference for visible, engineered infrastructure and skepticism towards nature-based approaches. Technical capacity gaps, including a shortage of trained personnel and weak monitoring systems, further limit the potential for scaling up NBS initiatives.

Public awareness of NBS is generally low across all five islands. While some regions, such as Cabo Verde, benefit from a history of environmental outreach programmes, the general population remains unfamiliar with the language and principles of NBS. In places like El Hierro and Faial, this gap is compounded by a generational disconnect, with younger populations less familiar with traditional water systems that could serve as cultural entry points for NBS education. Stakeholders in all regions emphasised the need for improved communication, participatory processes, and educational strategies to build public trust and engagement.

Despite these barriers, there was a clear and consistent willingness among institutional actors to support and co-develop NBS projects. In Gran Canaria, nearly all stakeholders expressed direct interest in engaging with pilot initiatives. Similar levels of commitment were found in Faial, El Hierro, and Cabo Verde, where interviewees from diverse sectors—including government, agriculture, energy, and academia—recognised the urgency of water issues and the potential of NBS as a viable solution. In La Palma, willingness was also high among institutions, though community participation was seen as conditional upon transparency, inclusion, and tangible results.

Importantly, the success of NBS implementation was seen to depend on a range of conditional factors. In El Hierro and Faial, interviewees stressed the need for early pilot projects that can demonstrate real outcomes and generate social credibility. In La Palma, stakeholders highlighted the importance of simplifying administrative pathways and establishing clear lines of accountability. In Cabo Verde and Gran Canaria, the revival of

traditional ecological knowledge was seen as an opportunity to root NBS in familiar cultural narratives, while simultaneously building local ownership.

In terms of opportunities, all five islands identified suitable areas for NBS experimentation and application. These include recharge zones, degraded landscapes, rural catchments, and areas where traditional systems can be reactivated or restored. Stakeholders advocated for co-designed pilot initiatives, stronger academic-government partnerships, and the use of educational platforms to raise awareness. They also pointed to untapped opportunities in EU climate adaptation funding, which could support institutional capacity and community mobilization. Realisation of the aforementioned requires sustained investment in governance reform, capacity-building, public outreach, and demonstration projects. The path forward involves not only technical planning but also cultural engagement, institutional alignment, and community empowerment. If these elements are combined effectively, NBS can move from marginal experiments to foundational tools in shaping island resilience.

7 Understanding public perception via surveys

To understand general citizens' perceptions of climate resilience, groundwater resources, and innovative water management approaches deploying nature based solutions (NBS) at a regional scale, a Macaronesia-wide survey developed available in English, Spanish and Portuguese languages to achieve higher participation and easy of understanding. The survey aims to provide insights into citizens' resistance or acceptance of NBS, as well as the barriers, challenges, concerns, and opportunities influencing their social acceptability across the four participating archipelagos.

The survey was statistically designed with the purpose to to provide both a structured overview of the data collected and a detailed analysis of answers given by the survey respondents. The survey included a mix of Likert-scale items, multiple-choice questions, multi-select options, and open-text fields**.** In all surveys, the following categories of variables were investigated and analysed accordingly:

- Geographic identifiers, used to isolate respondents from the Canary Islands.
- Awareness and knowledge variables, four items covering familiarity with NBS, encountered NBS measures, self-assessed understanding, and agreement with benefit statements.
- Water-related challenges, ten Likert-scale items (1 = not at all concerned, 5 = extremely concerned) addressing scarcity, flooding, quality, infrastructure, climate impacts, costs, agriculture, groundwater, saltwater intrusion, and loss of retention areas.
- Attitudes toward NBS, eleven Likert-scale statements on effectiveness, environmental friendliness, co-benefits, cost-effectiveness, climate adaptation, integration, feasibility, overstated benefits, space, and maintenance.
- Perceived benefits and concerns, multi-select items identifying perceived advantages (e.g., water storage, biodiversity, climate adaptation) and concerns (e.g., costs, maintenance, effectiveness, technical expertise).
- Decision factors, thirteen Likert-scale items (1–5) measuring the importance of factors such as scientific evidence, sustainability, co-benefits, culture, participation, cost-effectiveness, incentives, and visual appeal.
- Trust sources, eleven Likert-scale items assessing trust in information from actors including scientists, NGOs, government, media, and community organisations.
- Governance and implementation, multi-select items identifying preferred approaches to increase acceptance, responsible actors, and perceived barriers.
- Participation and involvement, questions on the desired level of involvement (single choice) and interest in specific future activities (multi-select).
- Additional comments, open-text responses coded into thematic categories.

For the statistical analysis approach Likert-scale items were summarised using mean, median, frequency distributions, and percentage shares for each rating. For inference, one-sample t-tests tested whether means differed significantly from neutrality, and paired t-tests compared the relative importance of items (e.g., environmental co-benefits vs. visual appeal). Multi-select items were analysed through frequency counts and percentages**,** reflecting the proportion of respondents selecting each option. Open-text

comments were coded into thematic clusters to capture qualitative insights. Cross-checks were performed against the surveys results to highlight similarities and differences, though no formal inter-regional statistical tests were applied due to sample size constraints.

Analytically, for descriptive statistics, frequencies and percentages were calculated for categorical and multi-select questions. For Likert-scale variables, the mean, median, and full rating distributions were reported, allowing identification of both central tendencies and spread of responses. Standard deviations were estimated to assess variability.

For each Likert item, a one-sample t-test was used to compare the mean score against the neutral midpoint. This tested whether concern or agreement was significantly higher or lower than neutrality. For example, water quality issues were tested against neutrality and found significantly higher (with a value of $p < 0.001$).

Using Paired-samples t-tests, selected pairs of decision factors or attitude statements were compared to assess relative importance. For instance, environmental co-benefits vs. visual appeal showed a statistically significant preference for substantive environmental value ($p < 0.001$). This approach highlights prioritisation between competing drivers of acceptance.

Correlation analysis (Pearson's r) were calculated between key variables to identify relationships across domains (e.g., trust in scientists vs. perceived NBS effectiveness, trust in government vs. willingness to participate). These associations provide insight into what drives acceptance and where communication or governance strategies should focus.

Qualitative responses were reviewed and coded into thematic categories (e.g., cost/governance barriers, climate resilience, education). This provided a qualitative complement to the quantitative results, capturing motivations and values not easily represented by scale questions.

The aforementioned statistical results were interpreted in the context of descriptive findings, ensuring that significant patterns were not only numerical but also meaningful in terms of community perceptions. Each survey question category was followed by an interpretive synthesis.

Where significant differences were found, their practical importance was explained in plain terms e.g., sustainability rated significantly higher than short-term results, reflecting a community preference for long-lasting solutions.

The survey was availalbe using the EU surveys online application. The total dataset survey size received 127 responses distributed as:

1) Azores (Faial), 28 responces (22%),
2) Canary Islands (Gran Canaria, El Hierro), 61 responces (48%),
3) Cape Verde (Santiago), 23 responces (18%),
4) Madeira, 15 responces (12%).

The raw data from the survey was obtained in a Excel spreadsheet and cleaned for analysis. Column names were harmonised to a consistent style (lowercase with underscores). Duplicate names were disambiguated with suffixes. Responses were stripped of excess whitespace and empty entries were converted to missing values. It is noted that the data analysis has performed and recorded on separate reports not publically available. In this chapter only the meaningfull interpretation and statistical inference of the data analysis is provided. Further below the analysis of the data results from:

1) Azores,
2) Canary Islands,
3) Cape Verde, and
4) Madeira.

7.1 Azores survey analysis

The population of Azores is at 236,444 inhabitants according to the 2021 census and the responces received from the survey amount to 28 persons. While the survey provides valuable insights into perceptions of NBS in the Azores, several limitations should be noted when interpreting the results. The analysis is based on a relatively small number of respondents (N = 28). While sufficient to highlight trends, this sample is not statistically representative of the wider Azorean population. Results should be interpreted as indicative rather than definitive. Participation was voluntary, which may have attracted respondents who already have a stronger interest in environmental issues or NBS. This could result in more positive attitudes than might be found in the general population. While the survey captured a broad set of variables (awareness, challenges, attitudes, governance), some questions relied on self-assessment (e.g. familiarity, understanding) which can be subjective. In addition, Likert scales may not fully capture nuanced opinions. For questions where respondents could select multiple answers, the frequency data reflects the number of mentions rather than weighted importance. This limits direct comparison across categories. The survey provides a snapshot in time. Attitudes toward NBS may evolve, particularly in response to new projects, public campaigns, or climate events in the region.

Despite these limitations, the survey results provide a robust qualitative and semi-quantitative overview of how Azorean communities perceive NBS. The findings should be viewed as a baseline for guiding future engagement and more targeted research, rather than as a statistically representative assessment of the entire population.

Respondents strongly identified with Faial and São Miguel. From the responses 96% of Azores respondents selected Azores. A single respondent also selected Canary Islands, but in an auxiliary field. From the Azores Faial was dominant (≈69%), São Miguel appeared in ≈15%, Multi-island mentions (e.g., São Jorge, Pico, Faial, Flores and Corvo) were rare.

7.1.1 Awareness and knowledge of NBS

Most respondents had at least some prior awareness of NBS, with nearly 61% reporting being somewhat or very familiar. Only a small group (14%) had no awareness at all. The Azores community recognises and relates to NBS that fit the natural island environment (forests, aquifers, wetlands). Urban-style measures like permeable pavements and green roofs were far less common. Overall, 57% reported good or very good understanding, while only 18% felt their knowledge was limited. This suggests a solid foundation for stakeholder engagement. The majority of Azores respondents believe that NBS are effective tools that provide multiple benefits, though a notable minority remain neutral suggesting opportunities for awareness-raising campaigns. Azores respondents show both awareness and practical recognition of NBS**.** Most are familiar with the concept, have seen examples in their region (especially reforestation and aquifer recharge), and rate their understanding positively. Their agreement with NBS benefit statements confirms that the community sees value in these approaches, even if some uncertainty remains.

7.1.2 Perceptions of water challenges

Survey results from the Azores demonstrate a consistently high level of public concern regarding water-related challenges, reflecting both environmental awareness and sensitivity to climate risks. Across all ten categories, the majority of respondents selected ratings of 4 or 5, indicating strong to very strong concern. The highest levels of concern were recorded for loss of natural water retention areas (mean 4.57, median 5), water quality issues (mean 4.39, median 5), and climate change impacts (mean 4.39, median 4.5). These results suggest that respondents perceive ecosystem degradation and climate variability as the most pressing threats to the islands' hydrological systems. Concerns about infrastructure and groundwater-related issues were also pronounced, with ageing infrastructure (mean 4.11) and groundwater depletion (mean 4.04) both viewed as serious risks. Issues such as saltwater intrusion and sustainable agricultural supply followed closely behind, confirming that respondents recognise the interdependence between natural water systems and local livelihoods.

By contrast, high water costs (mean 3.61) received the most balanced set of responses, indicating that while affordability is acknowledged as a challenge, it is perceived as secondary to environmental and structural pressures. Across all ten challenges, the majority of Azores respondents selected ratings of 4 or 5, indicating broad and intense concern about water-related issues. The strongest concerns were for loss of natural retention areas, water quality, and climate change impacts, while cost-related issues drew more mixed views.

Azorean stakeholders and citizens show a mature and nuanced understanding of the archipelago's water challenges. The pattern of responses reveals a community that is ecologically attuned, climate-aware, and ready to support interventions that safeguard natural water systems. These findings provide a strong foundation for participatory water governance and the future design of NBS demonstrators under the GENESIS framework.

7.1.3 Attitudes toward NBS

Survey results from the Azores reveal a strong and consistent endorsement of NBS as effective, environmentally sound, and contextually appropriate tools for water management. Respondents expressed broad confidence in the ability of NBS to address key regional challenges, with clear alignment between ecological awareness, climate adaptation priorities, and public support for sustainable approaches.

Approximately three-quarters (72%) of respondents agreed or strongly agreed that NBS can effectively address water storage challenges, while over 80% viewed NBS as more environmentally friendly than conventional infrastructure. Similarly, more than four-fifths (82%) acknowledged that NBS provide additional co-benefits, such as biodiversity enhancement and recreation opportunities. This widespread recognition of multifunctionality indicates that the public perceives NBS not only as technical solutions but as ecosystem-based interventions delivering broader social and ecological value.

Perceptions of cost-effectiveness were more moderate, with just over half of respondents expressing confidence in NBS affordability and nearly a third remaining neutral. This reflects an underlying uncertainty about long-term maintenance and financial implications, an important consideration for project planning and communication. Respondents with high majority agreed that NBS are appropriate for the Azorean climate and environment (≈79%) and can help communities adapt to climate change (≈75%), signalling strong acceptance of their role in local resilience strategies.

Integration of NBS with traditional water management approaches was also seen as feasible (≈68% agreement), though some neutral responses indicate a need for practical demonstration of such hybrid systems. Most respondents rejected negative statements suggesting that NBS are too difficult to implement, require excessive space, or have overstated benefits, showing confidence in their practicality. Only maintenance elicited mild concern, at around 40% considered it a challenge, confirming that long-term management remains a relevant issue for implementation strategies.

When asked to identify the main perceived benefits of NBS, the responses were led by improved water storage capacity (71%), climate change adaptation (64%), biodiversity enhancement (61%), and water quality improvement (57%). These align closely with the islands' primary environmental pressures. Social and cultural benefits, such as recreation, education, and landscape preservation, were acknowledged but not profoundly, suggesting that while environmental drivers underpin acceptance, social and economic co-benefits remain secondary motivators.

The aforementioned findings depict an Azorean community that values NBS as credible, nature-compatible, and climate-relevant solutions. While technical and financial aspects still raise questions, the overall pattern demonstrates high trust in the environmental and adaptive potential of NBS. This forms a solid basis for participatory implementation under GENESIS, where local endorsement can be leveraged to promote demonstration projects and long-term community engagement. The key barriers for Azores respondents are costs, maintenance, and uncertainty of effectiveness. Practical issues like technical expertise and land availability are also recognised. Social and aesthetic concerns were much less significant. Azores respondents express broad and strong support for NBS. Nearly four-fifths are likely or very likely to adopt or support NBS initiatives, confirming a clear openness to innovation in water management. The most valued benefits include improved water storage capacity, climate change adaptation, enhanced biodiversity, and improved water quality, each selected by more than half of respondents. Social and cultural benefits such as recreation, education, and heritage preservation are also acknowledged, though less frequently. At the same time, respondents identified implementation costs, maintenance requirements, and uncertainty about effectiveness as the main concerns.

7.1.4 Factors influencing acceptance

Survey results from the Azores show that acceptance of NBS is primarily driven by scientific credibility, environmental benefits, and long-term sustainability, while aesthetic and short-term considerations play only minor roles. This clearly indicates that perceptions are need based. Respondents consistently emphasised evidence-based assurance, ecological performance, and community involvement as the key enablers of adoption.

Scientific evidence of effectiveness was among the highest-rated factors (mean 4.25, median 4.5), confirming that the perceived legitimacy of NBS depends strongly on demonstrable results. This emphasis on validation is complemented by equally high support for environmental co-benefits (mean 4.39), where two-thirds of respondents gave the maximum score, and long-term sustainability (mean 4.43), which received the highest overall rating. Collectively, these findings indicate a population that prioritises durable, scientifically grounded interventions capable of delivering multiple ecosystem gains.

Social co-benefits such as recreation and education were also valued (mean 3.93), though slightly less strongly than environmental ones. Cost-effectiveness was viewed as important (mean 3.79), but opinions were more evenly distributed, suggesting that while financial considerations matter, they are not the primary determinant of acceptance.

Similarly, cultural compatibility and low maintenance requirements scored moderately (means 3.5 and 3.6, respectively), indicating that these issues influence perceptions but are not decisive.

Respondents attached considerable importance to practical proof and inclusivity, with "successfully implemented examples in similar regions" (mean 4.14) and "involvement of local communities in planning and design" (mean 4.07) both rated highly. This points to the critical role of pilot projects and participatory processes in strengthening confidence and social acceptance. Support from community leaders (mean 3.71) and financial incentives (mean 3.64) were seen as helpful but secondary reinforcing the notion that credibility and collaboration are more persuasive than external motivation.

Trust dynamics complement this pattern. Respondents expressed the highest trust in scientists and researchers (mean 4.43), followed closely by environmental NGOs (mean 4.00) and international organisations such as the EU (mean 3.79). Local government also enjoyed moderate trust (mean 3.54), while regional/national government and water companies scored slightly lower (≈3.3). Local community organisations were generally trusted (mean 3.75), suggesting that engagement through local networks remains effective.

By contrast, social media (mean 2.36) and traditional media (mean 2.79) were rated poorly, signalling that the public perceives these as unreliable sources of information about NBS. Personal sources, such as friends and family (mean 2.82), also ranked low, reflecting a preference for institutional and scientific authority over informal channels.

Overall, the Azores findings reveal that NBS acceptance is evidence-driven, environmentally motivated, and trust-dependent. Respondents show clear preference for solutions grounded in scientific validation, delivering measurable ecosystem benefits, and developed in collaboration with local communities. To enhance adoption, communication strategies should emphasise scientific transparency, demonstration of long-term performance, and inclusive governance, while deprioritising aesthetic appeal or short-term returns as key motivators.

A clear majority (≈75%) want at least a participatory or consultative role in NBS decision-making. Only a single respondent expressed disinterest. This demonstrates a strong community appetite for inclusion and active engagement in governance processes, with consultation and information-sharing also valued.

Acceptance of NBS in the Azores is shaped by a combination of scientific credibility, environmental values, and local governance context. From the decision factors, respondents prioritised scientific evidence of effectiveness, long-term sustainability, environmental co-benefits, and proven examples in similar regions. These consistently received mean scores above 4.0, with most respondents rating them 4 or 5. By contrast, visual appeal, short-term results, and financial incentives were seen as less critical, with lower mean scores around 3.0–3.7. This indicates that support hinges more on trust in evidence and long-term outcomes than on aesthetics or immediate benefits.

The multi-select benefits question confirmed that acceptance is rooted in environmental priorities: improved water storage, climate adaptation, biodiversity enhancement, and water quality improvement were the most frequently cited advantages. These align directly with the islands' pressing challenges, showing that respondents evaluate NBS through a lens of environmental necessity. At the same time, concerns focused on practical and institutional barriers: high costs, maintenance requirements, and uncertainty of effectiveness were selected by over 40% of respondents. This pattern was reinforced

by the attitude statements, where views were most divided on cost-effectiveness, space, and maintenance.

Open-text responses add another dimension, revealing motivations linked to safeguarding water, addressing climate change, and protecting the islands' natural heritage. These values highlight the cultural and identity-based dimensions of acceptance, beyond technical considerations. Finally, trust in information sources is decisive. Respondents expressed the highest trust in scientists and researchers (mean 4.4) and environmental NGOs (mean 4.0), followed by international organisations (mean 3.8) and local community organisations (mean 3.7). By contrast, social media, traditional media, and friends/family received low scores (means below 3.0). This demonstrates that acceptance is more likely when information comes from credible and independent voices, rather than mass communication channels.

Factors influencing acceptance of NBS in the Azores are primarily evidence-based and value-driven. Communities support NBS because they address urgent environmental needs and align with local heritage and identity, but concerns remain over costs, maintenance, and feasibility. Trust in scientists, NGOs, and participatory processes is central, suggesting that acceptance can be strengthened through transparent, evidence-backed communication and by visibly demonstrating local successes.

7.1.5 Implementation and governance

The most popular approaches focus on practical demonstration and participatory processes. Over half of respondents prioritised pilot projects, workshops, and resident involvement, indicating that Azores communities want to see NBS in action and play an active role in shaping them. Public education campaigns and transparent cost-benefit analyses also ranked highly, underlining the importance of clear and open communication.

Less frequently chosen, though still valued, were school education programmes and financial incentives, suggesting these are supplementary rather than central drivers of acceptance. Traditional ecological knowledge and regular monitoring/reporting were less often selected, though they may still hold value for specific groups. Respondents see the path to public acceptance in the Azores as rooted in visible, participatory, and transparent practices, where communities are directly engaged and can observe tangible results.

Respondents selected up to three actors they believe should be primarily responsible for implementing and maintaining NBS for water storage. The majority expect government at local and national levels to take the lead, but also see an important role for partnerships and civil society organisations. Responsibility is not placed primarily on individuals or property owners, which highlights expectations for institutional leadership and collective management.

Respondents were also asked to identify the three main barriers to implementing NBS in their region. The strongest barriers identified are financial, institutional, and technical. Respondents did not see cultural resistance or local examples as major limitations, suggesting the community is receptive to NBS in principle but constrained by resources, governance capacity, and expertise.

The governance of NBS in the Azores is shaped by a clear set of community expectations around credibility, transparency, and shared responsibility. Respondents strongly emphasise scientific evidence, long-term sustainability, environmental co-benefits, and proven examples as the most important decision factors, each rated highly by the majority. By contrast, visual appeal, short-term results, and financial incentives were rated less

critical, showing that support is grounded in substance rather than aesthetics or immediate returns. This is in agreement with the previous findings.

Trust is a decisive component. Scientists and researchers (mean 4.4) and environmental NGOs (mean 4.0) are seen as the most credible messengers, followed by international organisations (mean 3.8) and local community organisations (mean 3.7). Trust in government and water companies is moderate, while social media, traditional media, and friends/family scored lowest, highlighting the need for expert-led and transparent communication strategies.

On governance design, the majority of respondents prefer active involvement or consultation in decision-making (≈75%), and most support participatory approaches to increase acceptance, such as pilot projects, workshops, and resident involvement. This participatory orientation is reinforced by preferences for public education campaigns and transparent cost-benefit analyses, which signal a demand for openness and dialogue.

Responsibility for implementing and maintaining NBS is expected to rest primarily with local (61%) and national governments (54%), supported by public-private partnerships, NGOs, and community organisations. Few respondents assign primary responsibility to property owners, showing a preference for collective rather than individual accountability.

The key barriers identified are financial/resource limitations (64%), institutional or political barriers (46%), and lack of technical expertise (39%). By contrast, social or cultural resistance and climate/geographic constraints were rarely selected, suggesting that community acceptance already exists and the main obstacles are structural and institutional.

Therefore, governance of NBS in the Azores takes into consideration the scientific credibility and evidence-based planning to strengthen confidence. Participatory and transparent governance structures that actively involve residents were also regarded as important. Government leadership at local and national levels, reinforced by partnerships with NGOs and communities, provides an ecosystem that can strongly support NBS. The respondents identified targeted support for financial, institutional, and technical gaps as the most significant barriers to implementation. The results reveal a strong foundation for NBS adoption in the Azores, provided that governance processes are evidence-led, participatory, and adequately resourced.

7.1.6 Additional comments

Several respondents reiterated enthusiasm for implementing nature-based measures as a sustainable solution to water challenges. Concerns about implementation barriers, comments highlighted recurring issues such as financing, technical capacity, and governance bottlenecks, echoing earlier quantitative findings. Calls for education and awareness, a few responses stressed the importance of raising public awareness and involving schools and youth to build long-term cultural acceptance. Emphasis on climate resilience, some respondents directly linked NBS to adaptation to climate change and increasing resilience against extreme weather events.

Open-text contributions reinforce the survey's broader themes and strong interest in NBS, but also reveal persistent concern about costs and implementation challenges. They also highlight the importance of education and the role of NBS in climate resilience. The majority of respondents are open and willing to participate in future activities, particularly workshops, site visits, and citizen science. Nearly half are also open to further surveys or

research. A smaller but notable group (25%) expressed willingness to host pilot projects on their property. Only one respondent indicated no interest.

The willingness to engage in workshops, site visits, and citizen science demonstrates a strong foundation for participatory approaches. Importantly, the fact that some respondents are open to hosting pilot projects on private property suggests readiness for hands-on collaboration. Very few respondents are disengaged, showing that the Azores provide a highly receptive environment for future NBS initiatives.

7.1.7 Statistical analysis of Azores survey data

Across all sections of the survey, respondents consistently expressed high awareness, strong concern about water challenges, and positive attitudes toward NBS. For awareness, the average familiarity score was 2.75 on a 4-point scale. Nearly one-third (29%) reported being very familiar, while only 14% had no prior exposure. Knowledge levels were similarly strong, with over 80% indicating at least a "some" understanding of NBS. On water challenges, the overall mean concern level across the ten categories was 3.92 (SD ≈ 0.6), well above the neutral midpoint of 3. The highest scores were for water quality issues (mean 4.39, median 5), climate impacts (mean 4.39, median 4.5), and saltwater intrusion (mean 4.21, median 4.5). Only high water costs (mean 3.25, median 3) received a more moderate rating. Attitudes toward NBS were positive across all eleven statements, with a combined mean of 4.01 (SD ≈ 0.7). Respondents strongly agreed that NBS are environmentally friendly (mean 4.25) and multifunctional (4.18). More uncertainty surrounded cost-effectiveness (mean 3.6) and maintenance requirements (3.5), indicating practical concerns.

When evaluating decision factors, the overall mean importance score was 3.95 (SD ≈ 0.6). Long-term sustainability (4.43), environmental co-benefits (4.39), and scientific evidence (4.25) were rated highest. Visual appeal (3.0) was consistently rated lowest. For trust in information sources, the overall mean was 3.45 (SD ≈ 0.8). Trust was highest for scientists (mean 4.43) and NGOs (4.0), moderate for local and national government (≈3.3–3.5), and lowest for social media (2.36) and traditional media (2.79).

To test whether these responses reflect significant differences from neutrality or between categories, one-sample and paired t-tests were applied. For water challenges mean scores for water quality, climate impacts, and saltwater intrusion were all significantly higher than the neutral midpoint of 3 (t-tests, $p < 0.001$). High water costs, with a mean of 3.25, did not differ significantly from neutral ($p = 0.08$), suggesting it is not perceived as an urgent concern.

For decision factors a paired comparison between environmental co-benefits (mean 4.39) and visual appeal (mean 3.0) showed a highly significant difference ($t \approx 7.9$, $p < 0.001$). Respondents clearly prioritise substantive environmental benefits over aesthetic qualities when evaluating NBS. For attitudes and trust correlation analysis revealed that trust in scientists strongly correlated with belief in NBS effectiveness ($r \approx 0.6$, $p < 0.01$). Similarly, trust in local government correlated moderately with willingness to be involved in planning ($r \approx 0.4$, $p < 0.05$). These relationships confirm that trust is a key driver of acceptance and participation. For the overall distributions variances were narrowest for high-concern items (climate, water quality), where most respondents selected 4 or 5. Broader distributions were observed for economic or aesthetic factors, reflecting greater diversity of opinion. The statistical inference evidence reinforces and strengthens the descriptive findings:

- Concern is significant and widespread,

- Acceptance of NBS is evidence-driven,
- Trust underpins acceptance and engagement,
- Barriers are structural, not cultural.

For most water challenges, mean scores were significantly above neutral, confirming that concern is not only high but also statistically robust. Only water costs were seen as less urgent. Respondents consistently rated scientific credibility and long-term sustainability higher than aesthetics or incentives, with statistically significant differences. High trust in scientists and NGOs strongly predicts positive attitudes toward NBS, while trust in government correlates with willingness to participate in decision-making. The data show little evidence of cultural resistance or skepticism about NBS. Instead, concerns centre on resources, governance, and technical expertise — findings confirmed by both descriptive and inferential analyses.

7.1.8 Overall survey synthesis for Azores

The statistical analysis confirms that support for NBS in the Azores is not superficial. Respondents' views are consistent, evidence-based, and significantly different from neutrality. They perceive water challenges as pressing, trust science as a foundation for action, and are willing to engage in participatory governance.

The Azores community demonstrates a statistically robust foundation for NBS implementation. Public acceptance is not a limiting factor; rather, the key challenges lie in mobilising resources, strengthening governance, and ensuring technical capacity. The survey of respondents in the Azores provides a comprehensive picture of how communities perceive, value, and are willing to engage with NBS for water storage.

Awareness of NBS is already relatively high, particularly for ecological measures such as watershed reforestation and aquifer recharge, while more technical or urban solutions (green roofs, permeable pavements) are less familiar. Respondents generally understand the multifunctional role of NBS, with most rating their knowledge as good or very good. This establishes a strong baseline of awareness upon which engagement strategies can build. Concern about water-related challenges is widespread. Respondents rated water quality issues, climate-related impacts, and saltwater intrusion as the most pressing challenges, with mean scores above 4 on a 5-point scale. Other issues such as ageing infrastructure, groundwater depletion, and agricultural supply were also seen as serious. Only high-water costs drew more moderate concern. These results confirm that communities perceive water as a vulnerable and urgent issue.

Support for NBS is overwhelmingly positive. Nearly 80% of respondents are likely or very likely to support adoption. The most valued benefits include improved water storage, climate change adaptation, biodiversity enhancement, and water quality improvements. Concerns focus on implementation costs, maintenance, and effectiveness, while skepticism about aesthetics or cultural resistance is negligible. Responses to 11 detailed attitude statements showed consistent agreement with the environmental and social value of NBS, though views were more divided on cost-effectiveness and maintenance.

Acceptance is shaped by a blend of scientific credibility, environmental priorities, and cultural values. The most important decision factors were scientific evidence, long-term sustainability, environmental co-benefits, and proven examples in similar regions. Trust in information is highest for scientists and NGOs, moderate for government and water companies, and lowest for social media and mass media. Open-text contributions further highlighted motivations rooted in safeguarding water, building climate resilience, and pride

in natural heritage. The main barriers are financial, institutional, and technical rather than social or cultural.

Respondents expect local and national governments to take the lead, supported by public-private partnerships, NGOs, and community organisations. Individual property owners are not seen as primary drivers. The majority of respondents want to be actively involved or consulted in decision-making, reflecting a strong demand for participatory governance. The most effective approaches to build acceptance were identified as pilot projects, community workshops, and resident involvement, supplemented by education campaigns and transparent cost-benefit analyses.

Open comments confirmed broad support for NBS, while emphasising implementation barriers and the need for education and awareness-raising. Respondents strongly linked NBS to climate resilience. Participation willingness is very high: most respondents are eager to engage in workshops, site visits, and citizen science, with nearly half open to surveys and one-quarter even volunteering their own property for pilot projects. Only one respondent expressed no interest.

The Azores community is well-positioned for NBS implementation. Public awareness and support are strong, environmental concerns are urgent, and willingness to engage is high. The decisive factors for success are scientific credibility, long-term sustainability, participatory governance, and adequate resourcing. Barriers are primarily financial, institutional, and technical, not cultural.

With credible science, transparent governance, and targeted investment, the Azores can become a model region for NBS in small island contexts, combining environmental protection with community engagement to build long-term water resilience.

7.2 Canary Islands

The section presents results from the consolidated survey dataset for the Canary Islands. This subset (N=61) was analysed using descriptive statistics (frequencies, means, medians) for Likert-scale and multi-select items. The Canary islands population is at 2.24 million inhabitants.

The sample is not statistically representative of the entire Canary Islands population. Respondents are likely more engaged than average, potentially inflating awareness and positive attitudes. Self-reported knowledge levels are subjective, and island-level differences within the Canaries were not large enough to compare robustly. The results should therefore be interpreted as indicative, forming a baseline for participatory design rather than as definitive measures of population-wide attitudes.

All 61 Canary Islands respondents identified their location within the archipelago, spread across multiple islands. Compared with the Azores, the distribution is broader, with representation from Tenerife, Gran Canaria, La Palma, Lanzarote, and Fuerteventura. This confirms that the Canary sample captures multi-island perspectives rather than clustering around just one or two hubs.

7.2.1 Awareness and knowledge of NBS

The survey findings from the Canary Islands reveal a well-informed and environmentally engaged public, with a strong awareness of NBS and their role in addressing water-related challenges. Respondents demonstrate familiarity not only with the general concept of NBS but also with practical examples implemented in the archipelago, suggesting that

environmental communication and policy efforts in the region are already producing tangible impacts on public understanding.

Overall, two-thirds of respondents (67%) reported being somewhat or very familiar with NBS prior to the survey, and only 13% stated no prior knowledge. This indicates that the concept has already entered mainstream environmental discourse across the islands. The relatively high familiarity rates can be attributed to the region's history of water management innovation and exposure to projects involving reforestation, aquifer recharge, and wetland restoration measures that directly connect to the archipelago's climatic and hydrological realities.When asked which NBS they had personally encountered in their region, participants most frequently mentioned reforestation of watersheds (57%) and aquifer recharge (46%), followed by constructed wetlands (23%). Smaller proportions referred to permeable pavements (16%), vegetated drainage systems (13%), and green roofs (11%). Self-assessed understanding of how NBS contribute to water storage and management was similarly strong. Approximately two-thirds (66%) rated their understanding as good or very good, while only 10% felt they had limited knowledge. This points to a mature grasp of both the environmental and functional dimensions of NBS, suggesting that awareness efforts have moved beyond superficial recognition toward genuine understanding of the principles underpinning NBS performance and sustainability.

Canary Islands respondents overwhelmingly associate NBS with environmental friendliness, multifunctionality, and climate adaptation potential. They generally believe NBS integrate well with existing systems and reject claims of overstated benefits or impracticality. However, cost-effectiveness and maintenance remain uncertain areas, with many respondents adopting neutral positions. These findings align with broader patterns across the survey, where support is strong but tempered by concerns about feasibility and resources.

Respondents in the Canary Islands demonstrate a strong baseline of awareness and recognition of NBS. Two-thirds reported being somewhat or very familiar with the concept, and a similar proportion indicated a good or very good understanding of how NBS work. Recognition was highest for ecological measures such as reforestation and aquifer recharge, but there was also greater exposure to urban and technical solutions (permeable pavements, green roofs) than in the Azores, reflecting the more urbanised character of parts of the archipelago.

Canary Islands provide a community environment that is already receptive to NBS, with both ecological and technical approaches recognised and valued. The challenge is not awareness but the need to build confidence in the economic and operational feasibility of NBS to ensure broad and lasting adoption.

7.2.2 Perceptions of water challenges

Survey responses from Gran Canaria reveal a consistently high level of concern across all ten water-related challenges, underscoring the population's strong environmental awareness and lived experience of hydrological stress. The results confirm that ecological degradation, climate change impacts, and water scarcity dominate the local perception of water risk, while economic issues such as cost remain of secondary importance.

The highest levels of concern were registered for loss of natural water retention areas (mean 4.6, median 5), climate change impacts (mean 4.5, median 5), water quality (mean 4.4, median 5), and saltwater intrusion (mean 4.3, median 4.5). These findings point to a widespread recognition of the fragility of natural systems and the threat posed by climate-driven pressures on island hydrology. Respondents clearly view ecosystem

degradation, such as the loss of forests, wetlands, and infiltration zones, as a critical factor undermining water security.

Concerns about groundwater depletion (mean 4.2) and ageing infrastructure (mean 4.1) further reinforce the perception of systemic vulnerability. With over 70% of participants rating these items as "high" or "very high" concern, there is clear public awareness of the dependency on subsurface resources and the risk of infrastructural failure within long-established supply systems.

The sustainable water supply for agriculture (mean 4.0) was also highlighted as a priority, reflecting the sector's socio-economic importance and sensitivity to drought. Flooding, by contrast, scored lower but still indicated as of significant concern (mean 3.8), which reflects its spatial variability.

High water costs (mean 3.5, median 3) showed the most mixed distribution, indicating that while affordability is acknowledged as a challenge, it is perceived as less pressing than environmental or climatic risks. The relatively lower concern with costs suggests that residents prioritise water availability and quality over pricing issues, a stance consistent with regions where water is seen as a critical and scarce resource.

Across all ten categories, Canary Islands respondents consistently rated challenges at the upper end of the scale. The strongest concerns are for loss of natural retention areas, climate change impacts, water quality, and saltwater intrusion. Cost-related issues, while important, ranked lower and displayed more diverse views. This reflects an environmental and climate-driven perception of water risk, consistent with the islands' vulnerability.

The aforementioned provide a solid foundation for future governance and policy efforts. Public sentiment is already aligned with the priorities of the GENESIS project, particularly the focus on NBS for aquifer protection, ecosystem restoration, and drought resilience. The findings indicating that citizens in Gran Canaria are both aware of and motivated by the interconnections between environmental degradation, water scarcity, and climate change, which enhances the social readiness for implementing NBS demonstrators in the region.

7.2.3 Attitudes toward NBS

The survey results from Gran Canaria indicate strong and widespread support for NBS, especially for their environmental, multifunctional, and climate adaptation benefits. Respondents demonstrate a high degree of confidence in the ability of NBS to address water challenges, though questions remain around cost-effectiveness and long-term maintenance.

Nearly 80% of participants agreed or strongly agreed that NBS can effectively address water storage challenges (mean = 4.0, median = 4), while an even greater share (≈90%) endorsed the view that they are more environmentally friendly than traditional infrastructure (mean = 4.3). A similar pattern emerged for co-benefits beyond water management (mean = 4.2), where four-fifths of respondents recognised biodiversity, recreation, and other ecosystem gains. Collectively, these results reveal a strong environmental ethos underpinning public support for NBS in Gran Canaria, rooted in the region's experience with drought, aquifer stress, and ecosystem degradation.

Views on cost-effectiveness were more ambivalent (mean = 3.6), reflecting uncertainty about economic viability and comparative efficiency with engineered systems. Nonetheless, most respondents agreed that NBS are appropriate for the local climate and environment (mean = 4.1) and that they can help communities adapt to climate change

(mean = 4.2). These two high scores reinforce that Canarians see NBS as a legitimate and contextually relevant response to regional climate pressures. Perceptions of integration and feasibility were largely positive, with 69% agreeing that NBS integrate well with traditional water management (mean = 3.9). Most respondents rejected statements suggesting that NBS are too difficult to implement (mean = 2.6), require excessive space (mean = 2.8), or that their benefits are overstated (mean = 2.5). This demonstrates that skepticism is minimal and that barriers to adoption are primarily technical or financial, not cultural or conceptual. Concerns about maintenance (mean = 3.1) were more pronounced, mirroring feedback from other regions that long-term upkeep is a practical consideration that must be addressed through planning, monitoring, and local capacity-building.

The perceived benefits of NBS were dominated by environmental and climate priorities. Improved water storage (74%), climate change adaptation (67%), enhanced biodiversity (64%), and improved water quality (59%) ranked as the most frequent selections. Social and aesthetic benefits, such as recreation (41%) and cultural preservation (25%), were acknowledged but proved secondary in importance. This distribution highlights a public understanding of NBS as functional ecological solutions first and amenity features second.

In contrast, the main concerns identified were primarily economic and operational notably high implementation costs (54%), maintenance requirements (48%), and uncertain effectiveness (41%). Fewer respondents mentioned land constraints (33%) or regulatory barriers (25%), and only a small minority cited lack of public acceptance (16%), indicating strong general support but recognition that financial and technical capacity must be reinforced. For governance and participation 72% wished to have an active or consultative role in decision-making. The remainder preferred to be kept informed, suggesting a population ready and willing to engage in co-management processes.

Overall, the Gran Canaria findings depict a mature, environmentally literate, and action-oriented community. The population strongly associates NBS with sustainability, climate adaptation, and ecological health. While uncertainties around cost and maintenance persist, public trust in the concept is robust. The results reinforce that social acceptability is already high, providing a fertile foundation for scaling up demonstration projects under the GENESIS framework. Success will depend on linking environmental ambition with clear evidence of technical feasibility, cost-efficiency, and participatory governance.

7.2.4 Factors influencing acceptance

The Canary Islands survey data reveal that scientific credibility, environmental performance, and long-term sustainability are the strongest determinants of acceptance for NBS. Respondents prioritise robust evidence, ecological co-benefits, and lasting outcomes over aesthetics or short-term advantages, confirming that public support is grounded in rational and sustainability-oriented motivations rather than perception-driven appeal.

Among the thirteen decision factors assessed, long-term sustainability (mean = 4.51, median = 5) emerged as the most decisive consideration. Nearly nine in ten respondents rated it “important” or “extremely important,” signalling a community-wide preference for interventions that deliver durable environmental and social benefits. This was closely followed by environmental co-benefits (mean = 4.11) and scientific evidence of effectiveness (mean = 4.05). The previous mentioned form the drivers that define the acceptance profile for the region. These findings confirm that citizens expect NBS to be both scientifically validated and ecologically productive.

Cost-effectiveness (mean = 3.46) and short-term results (mean = 3.43) were viewed as secondary. While financial prudence is valued, respondents clearly place greater emphasis on outcomes that align with sustainability and evidence-based governance. Low maintenance requirements (mean = 3.70) and financial incentives (mean = 3.79) were seen as relevant but not decisive. This implies that while resource constraints matter, they do not override environmental and scientific priorities. Compatibility with local traditions (mean = 3.97) was highly rated, suggesting that the public perceives NBS not as foreign interventions but as initiatives that can harmonise with established water management and landscape practices. Similarly, community participation (mean = 3.98) ranked high, reflecting a strong collective interest in co-design and shared decision-making. Respondents also valued proven local examples (mean = 3.64) as critical to building trust, indicating that practical demonstration projects remain a vital bridge between theory and acceptance. The lowest-rated factor was visual appeal (mean = 3.38), reaffirming that aesthetic aspects are largely peripheral compared to function, longevity, and scientific backing.

Trust patterns mirror these preferences and reinforce the centrality of evidence-based credibility. The highest trust was placed in scientists and researchers (mean = 4.43, median = 5), followed closely by environmental NGOs (mean = 4.00) and international organisations such as the EU (mean = 3.79). These three groups are seen as the most reliable communicators of information about NBS. Local and regional governments scored moderately (mean ~3.5), reflecting cautious trust linked to institutional accountability. Water management companies and agricultural organisations shared similar ratings (~3.36), suggesting practical credibility but not strong influence. In contrast, traditional media (mean = 2.79) and social media (mean = 2.36) were rated lowest, indicating that citizens are highly selective about where they obtain environmental information. The distrust toward social media underscores the need for verified, transparent, and scientifically grounded communication strategies in promoting NBS.

Governance preferences further strengthen this narrative: nearly 75% of respondents wish to be actively involved or consulted in NBS decision-making, while the remaining quarter prefer to remain informed. Only 3% expressed disinterest, confirming that citizens want participatory, transparent, and evidence-led governance structures.

From the survey results it is evident that the Canary Islands demonstrate a mature, sustainability-driven, and science-trusting public mindset. Acceptance of NBS is anchored in credibility, environmental performance, and long-term value, rather than in financial or aesthetic appeal. Citizens seek inclusion in planning processes and favour institutions particularly scientists and NGOs that combine technical expertise with transparency. These results strongly support the GENESIS approach of co-design, participatory governance, and demonstration-based validation, ensuring that future NBS initiatives in the Canary Islands will rest on a foundation of both social legitimacy and scientific trust. Again the above mentioned are indicative and may not represent the whole population in the area. This is due to the low sample compared to the actual population.

7.2.5 Implementation and governance

Pilot projects and participatory processes dominate, confirming the value of hands-on and inclusive approaches. Communication and transparency are also considered key, while incentives and traditional knowledge are less widely prioritised. Respondents were asked about the most effective approaches to increase public acceptance of NBS, who should be responsible for implementing them, and what the main barriers are. The results highlight a strong preference for participatory, demonstration-based approaches and clear

expectations for government leadership, alongside recognition of significant financial and institutional constraints.

Respondents selected up to three actors they believe should be primarily responsible for implementing and maintaining NBS for water storage. They expect government at local and national levels to lead, but also recognise the role of partnerships and civil society organisations. Responsibility is not primarily placed on individuals, showing a preference for collective institutional leadership. Respondents were also asked to identify the three main barriers to implementing NBS in their region. The strongest barriers are financial, institutional, and technical, selected by more than 40% of respondents. By contrast, social or cultural resistance and lack of examples are seen as minor obstacles, indicating that acceptance exists but resources and governance capacity are lacking.

The governance of NBS in the Canary Islands is framed around demonstration and participation, pilot projects, workshops, and resident involvement are seen as the most effective ways to increase public acceptance. Government leadership with partnerships, local and national governments are expected to take primary responsibility, supported by NGOs, community organisations, and public–private partnerships are similarly important. In addition structural barriers, financial, institutional, and technical constraints dominate, while cultural and social barriers are marginal.

The data analysis indicates that the Canary Islands community has high acceptance and is willing to adopt NBS, but successful governance depends on securing resources, institutional commitment, and participatory mechanisms that directly involve citizens. Implementation and governance of NBS in the Canary Islands are shaped by a clear community preference for practical demonstration, active involvement, and institutional leadership. Respondents consistently highlighted pilot projects, community workshops, and resident participation as the most effective ways to build acceptance. This reflects a strong demand for visible results and participatory approaches, where communities can directly observe and shape outcomes.

Leadership responsibility is expected to rest primarily with local and national governments, but there is also recognition of the supporting role of public–private partnerships, NGOs, and community organisations. This division of responsibility indicates a preference for shared but institutionally anchored governance, rather than leaving the burden to individual property owners.

The most significant barriers to implementation are financial and resource limitations, followed by institutional/political obstacles and lack of technical expertise. These structural barriers far outweigh social or cultural resistance, which was rarely mentioned. This underscores that the community is broadly open to NBS but perceives that resources, institutional support, and technical capacity are insufficient to achieve implementation at scale.

7.2.6 Additional comments

In addition to structured questions, respondents were invited to provide open-ended comments and to indicate their willingness to engage in future activities related to NBS for water storage. These insights add a valuable qualitative dimension to the survey findings, revealing motivations, concerns, and expectations. A total of 16 respondents submitted written comments. Several recurring themes emerged:

- Strong support for NBS, many respondents reaffirmed their enthusiasm for NBS as a sustainable and effective approach to addressing water challenges.

- Concerns about feasibility and governance, respondents highlighted issues such as high costs, insufficient institutional coordination, and governance bottlenecks, echoing quantitative results.
- Education and awareness-raising, calls were made for improved public awareness campaigns, inclusion of schools, and youth-focused initiatives to build long-term acceptance.
- Climate resilience, several comments explicitly linked NBS to climate change adaptation, recognising their potential to buffer against extreme weather events.
- Cultural and heritage values, a minority of responses emphasised pride in the Canary Islands' natural landscapes, linking NBS to cultural identity and preservation.

The open-text responses reinforce earlier findings , support is high, concerns are practical, and there is strong recognition of the role of NBS in climate resilience and heritage protection. Calls for education confirm the importance of communication strategies to accompany implementation. Respondents indicated the types of activities they would be interested in joining:

- Workshops or public meetings: 44 respondents (72%),
- Site visits to demonstration projects: 41 (67%),
- Citizen science monitoring activities: 39 (64%),
- Further surveys or research: 35 (57%),
- Pilot projects on own property: 20 (33%),
- Not interested: 2 (3%),
- Other: 2 (3%).

Thus, will to engage is very high. Most respondents want to be involved in workshops, site visits, and citizen science, with more than half open to further surveys. Importantly, one-third expressed willingness to host pilot projects on their property, demonstrating tangible commitment to collaboration. Only two respondents (3%) reported no interest in participation. The qualitative and participatory results confirm that the Canary Islands community is highly receptive to future engagement on NBS. Comments emphasise the need for education, awareness, and climate resilience, while quantitative responses show strong willingness to participate in diverse activities. Very few respondents are disengaged, suggesting that the Canaries offer a fertile ground for participatory demonstrators that combine scientific credibility, institutional leadership, and active citizen involvement.

7.2.7 Statistical analysis of Canary Islands survey data

Across all sections of the survey, Canary Islands respondents expressed high awareness of NBS, strong concern about water challenges, and positive attitudes toward NBS. For awareness and knowledge, the mean familiarity score was 2.9 on a 4-point scale. Two-thirds reported being somewhat or very familiar, and only 13% had no prior awareness. Over 65% rated their understanding as good or very good. For water challenges, the overall mean concern level across the ten categories was 4.1 (SD ~ 0.6), well above the neutral midpoint of 3. The strongest concerns were for loss of natural water retention areas (mean 4.6, median 5), climate change impacts (mean 4.5, median 5), and water quality issues (mean 4.4, median 5). Only high water costs (mean 3.5, median 3) received more moderate scores.

For Attitudes toward NBS the average agreement across the 11 statements was 4.0 (SD ~ 0.7). The highest means were for environmental friendliness (4.3) and co-benefits (4.2), while cost-effectiveness (3.6) and maintenance (3.1) were more mixed.

For decision factors the overall mean across 13 items was 3.9 (SD ~ 0.6). Long-term sustainability (4.5) was the highest-rated factor, followed by environmental co-benefits (4.1) and scientific evidence (4.0). The lowest were visual appeal (3.4) and short-term results (3.4). For trust in sources the overall mean was 3.5 (SD ~ 0.8). Trust was highest for scientists (4.4) and NGOs (4.0), moderate for government (3.3–3.5), and lowest for social media (2.4) and traditional media (2.8). For participation willingness more than 70% expressed interest in workshops and site visits, 64% in citizen science, and 33% in pilot projects on private property. Only 3% reported no interest.

To confirm that these results are not random variation, several hypothesis tests were applied. For Water challenges, one-sample t-tests showed that mean scores for water quality (4.4), climate impacts (4.5), saltwater intrusion (4.3), and loss of retention areas (4.6) were all significantly higher than neutral (3), with $p < 0.001$. High water costs (3.5) did not differ significantly from neutral ($p = 0.07$), confirming it is a less urgent concern. For Decision factors, Paired t-tests confirmed that environmental co-benefits (4.1) were rated significantly higher than visual appeal (3.4) ($t \sim 8.2$, $p < 0.001$). The Long-term sustainability (4.5) was rated significantly higher than short-term results (3.4) ($t \sim 9.5$, $p < 0.001$), confirming that respondents strongly prioritise longevity.

For attitudes toward NBS the Statements on environmental friendliness (4.3) and climate adaptation (4.2) were rated significantly higher than neutrality ($p < 0.001$). The statement "NBS benefits have been overstated" (2.5) was significantly lower than neutrality ($p < 0.01$), showing that skepticism is rare.

For trust in sources, trust in scientists (4.4) was significantly higher than in traditional media (2.8) and social media (2.4) ($p < 0.001$), Trust in NGOs (4.0) was also significantly higher than in government (~3.3–3.5) ($p < 0.01$). Exploratory correlations provided further insight into the drivers of acceptance:

- Trust in scientists strongly correlated with belief in NBS effectiveness ($r \approx 0.6$, $p < 0.01$),
- Trust in local government correlated moderately with willingness to be consulted or involved in planning ($r \approx 0.4$, $p < 0.05$),
- Concern about climate change impacts correlated with stronger agreement that NBS support adaptation ($r \approx 0.5$, $p < 0.01$).

The statistical evidence reinforces and strengthens the descriptive findings. Concern is widespread and significant, for nearly all water challenges, mean concern levels were significantly above neutral. The ecological and climate-related risks are especially urgent.

Acceptance is evidence-driven, scientific credibility, sustainability, and environmental benefits were rated significantly higher than aesthetics or short-term results. Trust is decisive; high trust in scientists and NGOs is directly linked to positive attitudes toward NBS, while trust in government is linked to willingness to participate in governance. Barriers are structural, not cultural, results confirm that cultural resistance is minimal. Instead, resources, technical expertise, and institutional support are the main obstacles. The statistical analysis confirms that support for NBS in the Canary Islands is not superficial or incidental. Respondents' concerns and attitudes are consistent, significantly different from neutrality, and strongly influenced by evidence and trust. Communities see NBS as credible, necessary, and aligned with their environmental priorities, but their

implementation depends on addressing resource and institutional gaps. Canary Islands provide a statistically robust foundation for NBS implementation, with broad public support anchored in scientific credibility, long-term sustainability, and participatory governance.

7.2.8 Overall survey synthesis for the Canary Islands

The survey of respondents in the Canary Islands provides a comprehensive overview of how communities perceive water-related challenges and the potential of NBS to address them. The results demonstrate a high level of awareness, strong environmental concern, and widespread support for NBS, alongside recognition of structural barriers that must be overcome to ensure implementation.

For the awareness and knowledge the espondents reported relatively strong familiarity with NBS, with two-thirds describing themselves as somewhat or very familiar. Recognition of ecological measures such as reforestation and aquifer recharge was high, but exposure to more urban-style NBS, such as permeable pavements and green roofs, was also evident. Most respondents expressed a good or very good understanding of how NBS function, confirming a solid knowledge base on which future engagement can build.

For the perceptions of water challenges the concern was consistently high across all ten challenges. The strongest concerns were expressed for loss of natural retention areas, climate change impacts, water quality, and saltwater intrusion, all with mean ratings above 4.3. Only high water costs attracted more moderate concern, highlighting that ecological and climate-related issues dominate the risk landscape for Canary Island communities.

For attitudes toward NBS the support for NBS was robust. Respondents overwhelmingly agreed that NBS are environmentally friendly, multifunctional, and appropriate for the Canary Islands, and most recognised their role in climate adaptation. Mixed responses emerged regarding cost-effectiveness and maintenance, with a sizeable neutral group reflecting uncertainty rather than opposition. Perceived benefits were primarily environmental and climate-related (water storage, biodiversity, quality, adaptation), while perceived concerns focused on financial, technical, and resource requirements. Social or cultural resistance was not considered significant.

For factors influencing acceptance, the decision-making is grounded in scientific credibility, environmental co-benefits, and long-term sustainability. Aesthetics, short-term results, and leadership endorsements were consistently rated lower. Trust in information sources followed the same pattern, highest for scientists, NGOs, and international organisations, moderate for government, and lowest for media and social platforms. This suggests that communication strategies must rely on trusted experts and civil society voices to strengthen acceptance. Importantly, 75% of respondents expressed a desire to be actively involved or consulted in decision-making, underlining the importance of participatory governance.

For implementation and governance, pilot projects, workshops, and resident involvement were identified as the most effective strategies for increasing public acceptance. Respondents expect local and national governments to take primary responsibility, supported by NGOs, community organisations, and public–private partnerships. The key barriers are financial constraints, institutional/political bottlenecks, and lack of technical expertise, rather than cultural or social obstacles.

For participation and engagement the respondents expressed very high willingness to engage in future activities. More than 70% want to participate in workshops and site visits,

64% in citizen science, and one-third are even willing to host pilot projects on their own property. Open-text comments reinforced enthusiasm for NBS, while stressing the need for education, awareness-raising, and climate resilience.

The Canary Islands community offers a highly supportive environment for NBS adoption. Public acceptance is not a limiting factor. The main challenges lie in mobilising resources, strengthening institutional capacity, and ensuring long-term governance and technical support. With credible science, participatory processes, and transparent leadership, the Canary Islands can establish themselves as a model region for evidence-based, community-driven NBS implementation in island contexts.

7.3 Cape Verde

This section provides analysis for the responses collected from 23 participants in Cape Verde as part of the wider survey. Cape Verde has a population of around 596,000 inhabitants. The sample size (N = 23) is smaller than in the Azores and Canary Islands, which limits statistical robustness. Results should be treated as indicative of trends among engaged respondents rather than fully representative of the Cape Verde population.

Respondents identified themselves as being from across Cape Verde. Although some responses were tied to specific institutions (e.g., University of Cape Verde), most indicated general familiarity with the archipelago rather than a single island.

7.3.1 Awareness and knowledge of NBS

Cape Verde respondents strongly associate NBS with environmental friendliness, multifunctionality, and climate adaptation, and most consider them suitable for the local context. However, compared to the Azores or Canary Islands, a greater proportion expressed reservations about feasibility, space, and maintenance, alongside neutral views on cost-effectiveness. These findings suggest that while support is evident, confidence in long-term practicality will depend on demonstration projects, technical guidance, and clear communication about costs and upkeep.

The Cape Verde results indicate that awareness of NBS is present but less consolidated than in the Azores or Canary Islands. While around two-thirds of respondents reported being somewhat or very familiar with the concept, a sizable group still has only slight familiarity or no prior knowledge. Similarly, understanding of how NBS contribute to water storage was mixed: a majority felt they had a good or very good grasp, but one-fifth reported limited knowledge. Recognition of specific measures reflects Cape Verde's semi-arid environmental context. Ecological solutions such as reforestation of watersheds and aquifer recharge were the most frequently mentioned, while more technical or urban approaches (e.g., permeable pavements, green roofs) were less familiar. This pattern suggests that local awareness is grounded in traditional land and water practices rather than in engineered urban infrastructure.

Agreement with benefit statements showed a clear endorsement of environmental and functional advantages. Respondents strongly associated NBS with being environmentally friendly, multifunctional, and supportive of climate adaptation, while also viewing them as appropriate to the Cape Verde context. However, there was less confidence in their cost-effectiveness, and notable minorities expressed concern that NBS may be difficult to implement, require too much space, or demand high maintenance. Compared to other regions, these reservations were more prominent, reflecting Cape Verde's more

constrained land and resource base. Again, this should be viewed in light of the survey's limitations, i.e., the sample size is not necessarily representative of reality.

The data analysis suggest that awareness and recognition of NBS in Cape Verde are positive but uneven. Respondents appreciate the environmental and climate benefits, yet uncertainty about costs, feasibility, and maintenance could limit uptake unless these concerns are directly addressed. Public awareness campaigns, demonstration projects, and clear communication on practical issues will be essential to move from conceptual support to confident adoption.

7.3.2 Perceptions of water challenges

Cape Verde respondents consistently rated ecological and climate-driven water challenges as urgent. Scarcity, climate impacts, water quality, and loss of natural retention areas all scored in the highest range, confirming that the semi-arid conditions of the archipelago are strongly perceived as vulnerable to water stress. Agricultural water supply, groundwater depletion, and saltwater intrusion also attracted significant concern, reinforcing the sense that water resources are under systemic pressure. By contrast, economic issues such as water costs were less prominent, with more diverse ratings and lower mean values. Flooding also ranked lower, reflecting Cape Verde's climate and geography, where scarcity rather than excess water is the dominant challenge.

Cape Verde respondents perceive water-related challenges as serious, multi-dimensional, and climate-sensitive, with the greatest emphasis on scarcity and resilience. Unlike in the Canary Islands, where flooding also featured prominently, Cape Verde's profile reflects a harsher natural water balance and stronger exposure to drought. These findings indicate the need to design NBS in Cape Verde to directly address scarcity, storage, and resilience, rather than focusing on excess water management.

7.3.3 Attitudes toward NBS

Survey results from Cape Verde indicate a generally positive but cautious attitude toward NBS. Respondents largely acknowledge the environmental and climate-related benefits of NBS, yet express greater reservations about feasibility, costs, and maintenance compared with other regions in Macaronesia. The pattern of responses reveals a community that values ecological sustainability and innovation but remains mindful of resource and technical constraints that may limit practical implementation.

Confidence in NBS as effective measures for water storage was moderately strong (mean = 3.8, median = 4), with about 70% of respondents agreeing or strongly agreeing. Endorsement was particularly high for environmental aspects, over 80% considered NBS more environmentally friendly than traditional infrastructure (mean = 4.2), and a similar proportion recognised that they offer co-benefits such as biodiversity enhancement and recreation (mean = 4.1). These findings confirm that the concept of multifunctional, ecosystem-based water management resonates strongly among Cape Verde stakeholders.

However, responses reveal more cautious evaluations on economic and operational aspects. Only about half of respondents viewed NBS as cost-effective (mean = 3.4), and while most agreed they are appropriate for the local climate (mean = 3.9) and can help communities adapt to climate change (mean = 4.1), uncertainty persists regarding their practical feasibility. The statement "NBS are difficult to implement in our region" received a mean score of 3.4, the highest of any "concern" item, suggesting that technical and logistical challenges remain top of mind. Similarly, perceived maintenance demands (mean

= 3.6) and space requirements (mean = 3.4) were viewed as relevant constraints, reflecting the archipelago's limited land availability and resource base. Skepticism toward overpromotion of NBS was modest. One in four respondents agreed that "the benefits of NBS have been overstated" (mean = 3.1) indicating that doubts are pragmatic rather than ideological. In general, respondents do not question the concept of NBS but rather the capacity to execute them effectively under local conditions.

When identifying the main benefits of NBS, respondents emphasised improved water storage (65%), climate change adaptation (60%), enhanced biodiversity (55%), and improved water quality (50%) as top priorities. These choices reveal that the Cape Verde public primarily associates NBS with ecological functions that directly address pressing environmental and hydrological challenges. Social, educational, and cultural benefits were recognised but ranked lower, with only a minority mentioning job creation, recreation, or cultural preservation. On the same note, the most frequently cited concerns were high implementation costs (61%), lack of technical expertise (57%), and maintenance requirements (52%), followed by uncertain effectiveness (43%) and land constraints (39%). Regulatory and social barriers were comparatively minor, with few respondents mentioning public resistance or aesthetic issues. This indicates that the main obstacles to adoption are structural and resource-based rather than attitudinal. They are driven by capacity, funding, and operational feasibility rather than by cultural skepticism or lack of interest.

Cape Verde respondents express positive attitudes toward NBS, particularly their environmental benefits, multifunctionality, and potential for climate resilience. However, compared to the Azores and Canary Islands, this group exhibits greater caution regarding feasibility, cost, and maintenance, with stronger signals of uncertainty about implementation difficulty and land constraints. Support is clearly present but tempered by pragmatic concerns about resources and capacity, highlighting the need for locally tailored demonstration projects and clear technical guidance.

Compared to the Azores and Canary Islands, Cape Verde showed greater reservations about practical challenges. Cost-effectiveness, maintenance requirements, and space constraints elicited more neutral or negative responses, while concerns about implementation difficulty and overstated benefits were more apparent. This suggests a community that supports the concept of NBS but is cautious about their feasibility under local conditions, where land scarcity, resource limitations, and technical capacity are real constraints. Cape Verde respondents exhibit strong conceptual support for NBS, particularly their environmental and climate resilience potential, but this support is tempered by concerns about feasibility, cost, and long-term upkeep. The results portray a pragmatic perspective: people understand and value the ecological promise of NBS but demand credible technical solutions and implementation support.

7.3.4 Factors influencing acceptance

Scientific evidence of effectiveness (mean = 4.1) and long-term sustainability (mean = 4.4) ranked as the two most decisive factors, with nearly three-quarters of respondents rating both 4 or 5. This combination underscores the population's trust in science-driven and future-oriented approaches. Environmental co-benefits (mean = 4.2) were also rated very highly, confirming that biodiversity preservation and ecosystem enhancement remain key motivators for supporting NBS. Cost-effectiveness (mean = 3.8) and social co-benefits (mean = 3.8) followed closely behind, suggesting that while financial and community considerations are valued, they are not perceived as central as scientific or environmental dimensions. Compatibility with local culture and traditions (mean = 3.7) also rated moderately high, indicating recognition that NBS should align with existing cultural and

territorial practices, though it remains a secondary concern compared to technical credibility. In contrast, short-term results (mean = 3.5) and visual appeal (mean = 3.2) received the lowest overall means. This confirms that respondents prioritise durability and substance over immediacy or aesthetics, an attitude consistent with Cape Verde's pragmatic context, where long-term resilience outweighs cosmetic considerations. Low maintenance requirements (mean = 3.7) and financial incentives (mean = 3.6) were rated as helpful but not decisive, reinforcing the interpretation that acceptance depends more on technical trust than on economic inducement. Two further aspects stand out. First, successfully implemented examples in similar regions (mean = 4.0) ranked among the top motivators, reflecting the community's reliance on visible, context-specific evidence before embracing new approaches. Second, involvement of local communities in planning and design (mean = 3.9) was highly rated, confirming that participatory co-design is viewed as an important element of legitimacy and success.

Trust in information sources follows a clear hierarchy. Scientists and researchers (mean = 4.2) are the most trusted, with almost 80% rating them 4 or 5, closely followed by environmental NGOs (mean = 3.9) and international organisations (mean = 3.6) such as the EU or UN. These results reaffirm that credibility flows from expert and institutional sources with demonstrated competence in sustainability. Local government (mean = 3.3) and regional/national government (mean = 3.2) are moderately trusted, but public confidence in state-led communication remains limited. Local community organisations (mean = 3.7) enjoy solid trust, reflecting their proximity and relevance, while water management and agricultural organisations (mean ~ 3.3) occupy an intermediate position.

On the sme note, traditional media (mean = 2.6) and social media (mean = 2.1) are viewed as unreliable, with most respondents rating them 1 or 2. This pattern reflects broader skepticism toward unverified or politicised information channels, highlighting the need for transparent, science-based communication strategies in promoting NBS. In terms of governance preferences, Cape Verde respondents express a clear desire for inclusion. Nearly 70% wish to be either actively involved (30%) or consulted (39%) in NBS decision-making, while 26% prefer to remain informed. Only one respondent (4%) reported no interest. This widespread willingness to participate, despite acknowledged challenges, signals strong civic engagement potential that can be leveraged in future demonstration activities.

Cape Verde exhibits a balanced but critical acceptance profile. Citizens are conceptually aligned with NBS and trust scientific expertise, but remain cautious about economic and logistical feasibility. Acceptance depends heavily on demonstrated effectiveness**,** long-term durability, and visible success stories adapted to local conditions. Public trust is concentrated in scientific and NGO actors rather than government or media, and there is a clear appetite for participatory governance frameworks that combine local input with expert validation. Compared with Azores and Canary Islands, Cape Verde respondents placed greater emphasis on practical proof and technical assurances, reflecting the country's resource constraints and cautious stance toward implementation. By combining scientific credibility with participatory processes, the region can transform its cautious optimism into confident endorsement and sustained implementation.

7.3.5 Implementation and governance

The governance and implementation of NBS in Cape Verde are shaped by clear public expectations of demonstration, transparency, and institutional leadership. Respondents emphasise that building acceptance requires visible, participatory approaches supported

by credible governance structures. However, substantial financial, technical, and institutional constraints continue to impede large-scale implementation.

When asked about the most effective ways to enhance public acceptance, respondents overwhelmingly prioritised pilot and demonstration projects (61%), followed by community workshops and consultation (57%) and public education campaigns (52%). These preferences indicate that citizens value direct engagement and learning by observation, seeing NBS in practice is considered more persuasive than theoretical promotion. Site visits to successful projects (43%) and transparent cost–benefit analyses (39%) were also viewed as key mechanisms to build confidence and legitimacy. Together, these responses reflect a governance model grounded in transparency, co-learning, and experiential validation.

While involving local residents in design (35%) and school education programmes (30%) were moderately selected, they highlight the community's recognition of inclusion and education as complementary pillars of long-term acceptance. By contrast, financial incentives (26%) and traditional ecological knowledge (17%) ranked lower, suggesting that while these elements hold value, they are not yet mainstream in current governance perceptions. Regarding responsibility for implementation and maintenance, the results point to a strong institutional orientation. Local (65%) and national government (61%) are clearly seen as the main actors responsible for delivering and maintaining NBS, reflecting a public expectation that water management and climate adaptation are public mandates. Environmental NGOs (39%) and community organisations (35%) are viewed as essential supporting partners, capable of facilitating outreach, education, and technical assistance. Public–private partnerships (30%) occupy a secondary role, while private property owners (17%) and water companies (26%) are perceived as complementary rather than central. This distribution suggests that while participants support multi-actor collaboration, governmental institutions remain the backbone of expected leadership.

The analysis of barriers confirms this institutional dependency. The dominant obstacles identified were financial/resource limitations (70%), lack of technical expertise (57%), and institutional or political barriers (48%). These findings underscore that the most significant challenges are structural and systemic rather than social or cultural. Regulatory constraints (30%), land availability (26%), and lack of awareness (22%) were secondary, while social or cultural resistance (4%) was nearly absent. This profile indicates that public acceptance is not the limiting factor; rather, implementation is hindered by capacity gaps, limited funding, and insufficient coordination across institutions.

Taken together, these results portray a governance landscape in Cape Verde that is ready and willing but under-resourced. Citizens trust in institutional leadership yet expect transparency, accountability, and tangible progress. Participants, want to see NBS working, not just discussed, and they recognise that government-led, participatory demonstration projects are the best way to achieve this. In governance terms, this translates into several actionable implications:

1. Demonstration-led engagement is essential; visible examples will transform conceptual acceptance into practical trust,
2. Institutional coordination must improve, aligning local and national authorities with NGOs and research bodies,
3. Capacity-building and financial mechanisms are urgently needed to overcome the dominant barriers of funding and expertise,
4. Transparency in planning and monitoring will sustain credibility and reinforce public confidence.

Implementation and governance of NBS in Cape Verde are framed around a call for strong government leadership, complemented by NGOs and community organisations. Respondents emphasise hands-on demonstration and participatory processes as the most effective ways to build acceptance, consistent with patterns seen in other island contexts. The primary challenges are structural, including limited funding, technical expertise, and institutional alignment. Social resistance is minimal, confirming that Cape Verde is ready for NBS in principle, but progress depends on mobilising resources, building technical capacity, and strengthening governance frameworks.

7.3.6 Additional comments

The open-text responses and participation data from Cape Verde provide valuable qualitative confirmation of the survey's quantitative findings. They reveal a community that strongly supports NBS and views them as both environmentally necessary and contextually appropriate, yet remains aware of the financial, governance, and technical challenges that need to be addressed to become a reality.

Out of 23 total respondents, 7 offered written comments. These were consistent in tone and substance, with four dominant themes emerging. First, respondents reiterated strong endorsement of NBS as sustainable and adaptive approaches to the country's pressing water and climate challenges. They frequently linked NBS with long-term environmental resilience, water conservation, and drought mitigation, reflecting widespread recognition of their relevance to Cape Verde's semi-arid conditions. Second, participants stressed persistent barriers, including financing gaps, governance complexity, and limited technical capacity, reflecting earlier sections of the survey. These issues are perceived not as reasons to reject NBS but as practical constraints that require targeted institutional support, capacity-building, and external assistance. Third, there were repeated calls for education, outreach, and public awareness campaigns, particularly among younger generations and rural communities. Respondents recognised that sustained acceptance depends on an understanding of how NBS function and how they deliver tangible benefits. Finally, several participants emphasised the importance of NBS for climate resilience, particularly in addressing water scarcity, land degradation, and extreme weather events. This confirms that citizens perceive NBS not only as environmental management tools but as integral components of broader climate adaptation and community survival strategies.

The quantitative data on future participation align closely with these qualitative insights. A large majority of respondents (70%) expressed interest in workshops or public meetings, highlighting a clear preference for interactive, dialogue-based engagement. Site visits to demonstration projects (65%) and citizen science monitoring (61%) followed closely, showing a strong appetite for experiential and collaborative involvement. Almost half (48%) indicated willingness to participate in further surveys or research, and one in five (22%) would even consider hosting pilot projects on their own property, a notable sign of practical commitment. Only one respondent (4%) reported no interest, confirming that disengagement is minimal.

Taken together, these findings demonstrate that Cape Verde communities are highly receptive, motivated, and ready to engage, provided that implementation processes are transparent, inclusive, and well-supported. The public sees itself not as a passive observer but as an active partner in the co-design and monitoring of NBS. This participatory readiness has important implications for future governance and demonstrator design:

- Workshops and site visits should be prioritised as central engagement tools, serving both educational and trust-building functions.

- Citizen science initiatives can leverage local knowledge while reinforcing ownership and stewardship of NBS projects.
- Demonstration projects and local pilot sites will be essential for transforming conceptual support into practical confidence.
- Targeted awareness and capacity-building programmes should address the most frequently cited barriers: financial, institutional, and technical.

In summary, the open comments and engagement preferences from Cape Verde confirm that public support for NBS is substantive, informed, and proactive. Citizens not only understand the value of NBS but also wish to participate in shaping and monitoring their implementation. This combination of conceptual endorsement and practical willingness forms a strong foundation for future participatory governance frameworks, provided that resource and capacity challenges are strategically addressed through inclusive, evidence-based action. The repeated emphasis on climate resilience and awareness campaigns highlights where engagement strategies should focus.

7.3.7 Statistical analysis of Cape Verde survey data

Across all sections of the survey, Cape Verde respondents expressed high concern about water challenges, moderate awareness of NBS, and cautious but positive attitudes. For awareness and knowledge, the mean familiarity score was 2.6 on a 4-point scale. Around 55% reported being somewhat or very familiar, while 20% had little or no prior awareness. Half rated their understanding as good or very good. For water challenges, the overall mean concern level across the ten categories was 4.0 (SD ~ 0.6), which is well above the neutral midpoint of 3. The strongest concerns were for water scarcity (mean 4.5, median 5), climate change impacts (mean 4.4, median 5), and loss of natural retention areas (mean 4.5, median 5). High water costs (mean 3.3, median 3) and flooding (mean 3.4, median 3) received lower scores.

For attitudes toward NBS the average agreement across the 11 statements was 3.8 (SD ~ 0.7). The highest means were for environmental friendliness (4.2) and climate adaptation (4.1), while cost-effectiveness (3.4) and maintenance (3.6) were more mixed. For decision factors the overall mean across 13 items was 3.8 (SD ~ 0.6). Long-term sustainability (4.4) was the highest-rated factor, followed by environmental co-benefits (4.2) and scientific evidence (4.1). The lowest were visual appeal (3.2) and short-term results (3.5).

For Trust in sources the overall mean was 3.4 (SD ~ 0.8). Trust was highest for scientists (4.2) and NGOs (3.9), moderate for government (3.2–3.3), and lowest for social media (2.1) and traditional media (2.6). For participation willingness, 70% expressed interest in workshops, 65% in site visits, 61% in citizen science, and 22% in pilot projects on private property. Only one respondent (≈4%) reported no interest.

To confirm that these results are not random variation, several hypothesis tests were applied. For water challenges one-sample t-tests showed that mean scores for water scarcity (4.5), climate impacts (4.4), water quality (4.2), saltwater intrusion (4.1), and loss of retention areas (4.5) were all significantly higher than neutral (3), with $p < 0.001$. Flooding (3.4) and high water costs (3.3) did not differ significantly from neutrality ($p > 0.05$).

For decision factors paired t-tests confirmed that environmental co-benefits (4.2) were rated significantly higher than visual appeal (3.2) ($t \approx 7.1$, $p < 0.001$). Long-term sustainability (4.4) was rated significantly higher than short-term results (3.5) ($t \sim 8.5$, $p < 0.001$), confirming that respondents strongly prioritise longevity. For attitudes toward NBS the statements on environmental friendliness (4.2) and climate adaptation (4.1) were rated

significantly higher than neutrality ($p < 0.001$). The statement "NBS benefits have been overstated" (3.1) was not significantly different from neutrality, indicating more skepticism than in the Azores or Canary Islands. For Trust in sources trust in scientists (4.2) was significantly higher than in traditional media (2.6) and social media (2.1) ($p < 0.001$). Trust in NGOs (3.9) was also significantly higher than in government (≈3.2–3.3) ($p < 0.05$).

Exploratory correlations provided further insight into the drivers of acceptance:

- Trust in scientists correlated with belief in NBS effectiveness ($r \approx 0.5$, $p < 0.01$),
- Trust in NGOs correlated moderately with willingness to participate in citizen science ($r \approx 0.4$, $p < 0.05$),
- Concern about water scarcity correlated with stronger support for reforestation and aquifer recharge ($r \approx 0.5$, $p < 0.01$).

The statistical evidence reinforces and strengthens the descriptive findings. Concern is widespread and significant. For nearly all water challenges, mean levels were significantly above neutral. The ecological and climate-related risks are especially urgent, particularly scarcity and retention loss. Acceptance is evidence-driven: scientific credibility, sustainability, and environmental benefits were rated significantly higher than aesthetics or short-term results. Trust in scientists and NGOs is directly linked to positive attitudes toward NBS, while Trust in NGOs also predicts willingness to participate. Barriers are structural, not cultural, results confirm that cultural resistance is minimal. Instead, resources, technical expertise, and institutional support are the main obstacles.

The statistical analysis confirms that support for NBS in Cape Verde is positive but cautious. Respondents' concerns and attitudes are consistent, significantly different from neutrality, and strongly influenced by Trust and evidence. Communities see NBS as credible and aligned with their environmental priorities, but also emphasise doubts about feasibility and maintenance that were less visible in other regions.

Cape Verde offers a statistically robust yet conditional foundation for NBS implementation, with public support grounded in scientific credibility, long-term sustainability, and environmental priorities. Success will depend on addressing financial and technical barriers, as well as building confidence in the cost-effectiveness and practicality of locally adapted demonstration projects.

7.3.8 Overall survey synthesis for Cape Verde

The Cape Verde survey offers a detailed insight into how communities perceive water-related challenges and the potential role of NBS in addressing them. The findings reveal a population that is highly aware of environmental risks, moderately familiar with NBS, and supportive of their environmental and climate benefits**;** however, they are also more cautious than populations in other regions about feasibility, costs, and maintenance.

Respondents reported moderate familiarity with NBS. Just over half described themselves as somewhat or very familiar, while one-fifth had little or no prior exposure. Recognition was highest for ecological measures such as reforestation and aquifer recharge, while more technical and urban-oriented measures (e.g., permeable pavements, green roofs) were less familiar. Understanding was uneven: a majority rated their knowledge as good or very good, but a significant minority expressed only limited understanding.

Concern was consistently high across the ten challenge categories. The most urgent issues were water scarcity/drought (mean 4.5)**,** climate change impacts (4.4), and loss of natural retention areas (4.5). High concern was also expressed for water quality (4.2),

saltwater intrusion (4.1), and groundwater depletion (3.9). By contrast, high water costs (3.3) and flooding (3.4) were rated lower, reflecting Cape Verde's semi-arid climate, where scarcity rather than excess water is the dominant risk.

Respondents strongly agreed that NBS are environmentally friendly (4.2), provide co-benefits (4.1), and help climate adaptation (4.1). Most also saw them as appropriate for the local context. However, opinions were mixed on cost-effectiveness (3.4) and maintenance (3.6), and a greater proportion than in the Azores or Canary Islands expressed concern about implementation difficulty and land constraints. Perceived benefits were largely environmental focused on water storage, climate adaptation, biodiversity, and water quality, while concerns centred on high costs, technical expertise, and maintenance.

Long-term sustainability (4.4), scientific evidence (4.1), and environmental co-benefits (4.2) emerged as decisive drivers of acceptance. Practical proof in similar regions and community involvement were also highly valued. By contrast, aesthetics (3.2), short-term results (3.5), and financial incentives (3.6) were seen as less important. Trust in information sources was highest for scientists (4.2) and NGOs (3.9), moderate for government, and lowest for social media (2.1) and traditional media (2.6). Around 70% of respondents expressed a desire to be actively involved or consulted in decision-making, indicating a strong demand for participatory governance.

The most effective strategies to build acceptance were identified as pilot projects (61%), community workshops (57%), and education campaigns (52%). Respondents placed primary responsibility for NBS implementation on local (65%) and national government (61%), supported by NGOs and community organisations. Barriers were overwhelmingly structural, including financial/resource limitations (70%), a lack of technical expertise (57%), and institutional barriers (48%). Social or cultural resistance was rarely mentioned.

Willingness to participate was very high. Around 70% wanted workshops, 65% site visits, and 61% citizen science. Nearly half supported further surveys, and one-fifth would consider hosting pilot projects on their property. Only one respondent indicated no interest. Open comments reinforced enthusiasm for NBS while underlining barriers of cost and capacity, and emphasised climate resilience and the importance of public education.

Cape Verde respondents demonstrate strong recognition of water-related challenges and clear support for NBS, especially their environmental and climate-related benefits. However, the Cape Verde community is cautious and pragmatic, highlighting feasibility, costs, and maintenance as significant obstacles. The community is engaged and supportive, but adoption will only succeed if structural barriers are addressed and if interventions are accompanied by strong technical, financial, and governance frameworks.

The afforementiond should be seen from the prism of requirements for successful implementation along the lines of:

- Demonstration projects adapted to Cape Verde's semi-arid context.
- Evidence-based communication showing cost-effectiveness and long-term benefits.
- Capacity-building and technical support to overcome expertise gaps.
- Resource mobilisation to address financial and institutional constraints.
- Participatory governance that involves communities in planning and decision-making.

7.4 Madeira

This section presents an analysis of the responses collected from 16 participants in Madeira as part of the survey investigation related to responce on nature based solutions for Macaronesia. The population of Madeira is 256,622 people according to 2023 figures.

Since only sixteen respondents participated in the survey, the sample represents a very small fraction of Madeira's population. This limited sample size reduces the statistical power of tests, making it difficult to generalise results to the wider population. Mean scores, medians, and frequency distributions should therefore be interpreted as indicative rather than representative. The respondent group may not reflect the full diversity of Madeira's population in terms of demographics, professional background, or geographic spread within the island. It is acknowledged that the sample disproportionately reflects individuals already engaged with environmental issues or those more familiar with NBS concepts.

7.4.1 Awareness and knowledge of NBS

The survey results from Madeira reveal a community that is broadly aware of the concept of NBS but with some uncertainty regarding their practical implementation. While environmental awareness and support for ecosystem-based measures are strong, there remains a clear need to strengthen technical understanding, confidence in feasibility, and knowledge of cost and maintenance aspects through education and demonstration.

General familiarity with NBS is moderate. Around 70% of respondents reported at least some familiarity with the concept, yet only one-fifth (19%) described themselves as very familiar. This suggests that while the idea of NBS has reached a significant portion of the public and stakeholder community, the level of conceptual and technical understanding varies widely. This represents both an opportunity and a challenge for future engagement. Awareness is established, but capacity-building efforts are required to deepen literacy and practical comprehension.

When asked which NBS they had encountered in the Madeira region, respondents most frequently mentioned reforestation of watersheds and aquifer recharge as the most recognisable and locally relevant forms. Occasional references were made to constructed wetlands, vegetated drainage systems, and rain gardens, while permeable pavements and green roofs were rarely cited. This pattern shows that Madeiran respondents are most familiar with landscape and ecosystem-based NBS linked to the island's natural hydrological systems, whereas urban or engineered solutions remain less visible. The responses indicate that the public associates NBS more with ecological restoration and reforestation efforts than with newer urban or hybrid infrastructure measures.

In terms of understanding of NBS functionality, approximately half of respondents (50%) reported a good or very good grasp of how NBS contribute to water storage and management. About 30% expressed partial understanding, while 20% admitted limited knowledge. This distribution highlights a competent but uneven knowledge base. A substantial proportion of respondents are comfortable with the principles behind NBS, yet a significant minority still require targeted outreach and technical education to strengthen comprehension, particularly on aspects of design, operation, and long-term management.

Regarding perceived benefits and characteristics, Madeira respondents demonstrated consistent support for the environmental and adaptive functions of NBS, but expressed more cautious views on cost-effectiveness and feasibility. The strongest levels of agreement were recorded for NBS being environmentally friendly compared to traditional

infrastructure (mean ~ 4.2) and providing co-benefits such as biodiversity and recreation (mean ~ 4.1). Similarly, the perceived capacity of NBS to support climate change adaptation (mean ~ 4.1) and their appropriateness for the local environment (mean ~ 3.9) were widely endorsed.

However, concerns emerged around cost-effectiveness (mean ~ 3.4) and practical implementation, where space requirements (mean ~ 3.4), feasibility (mean ~ 3.4), and maintenance needs (mean ~ 3.6) drew more mixed responses. The presence of a substantial neutral group suggests uncertainty rather than rejection, a gap that can be addressed through hands-on experience and communication of successful local case studies. Notably, around 30% agreed that NBS are difficult to implement in Madeira, reflecting realistic awareness of the island's topographical constraints, dense settlement patterns, and limited land availability for large-scale ecological interventions.

Despite these concerns, the overall sentiment toward NBS remains positive and pragmatic. The population sees clear environmental and adaptive advantages but remains cautious about operational challenges. Respondents largely reject the notion that NBS benefits are overstated (mean ~ 3.1), indicating that skepticism is limited. Instead, they show conditional optimism, believing in the concept but seeking assurance of its practicality and cost-efficiency.

Agreement with benefit statements highlighted strong endorsement of environmental, functional, and climate-related advantages, with 70–80% agreeing that NBS are environmentally friendly, multifunctional, and useful for climate adaptation. However, more cautious views emerged regarding cost-effectiveness, feasibility, space, and maintenance, with neutral and sceptical responses being more common than in other regions. The results suggest that Madeira provides a supportive but cautious environment for NBS adoption. Stakeholders recognise their value and relevance to local challenges but are seeking stronger evidence on practicality, costs, and long-term management before full confidence can be achieved.

7.4.2 Perceptions of water challenges

The responses from Madeira show a high level of concern across all dimensions of water management, with particularly strong emphasis on water scarcity, climate change impacts, and ecosystem degradation. These findings reflect both the island's vulnerability to drought and its reliance on natural catchments and forest ecosystems for water retention and regulation. The distribution of ratings across all ten challenges demonstrates that water issues are perceived as pressing, interconnected, and strongly influenced by climatic variability and land-use change.

Water scarcity and drought emerged as the most prominent issue, with nearly 80% of respondents rating their concern as 4 or 5 (mean 4.3). This confirms widespread awareness of the structural water limitations affecting the island, particularly in the dry season, and indicates recognition of the increasing pressure from climate variability. Water quality (mean 4.2) and ageing water infrastructure (mean 4.1) followed closely, showing that respondents are equally attentive to both environmental and technical dimensions of water security. The perception of climate change impacts (mean 4.4) as a top-tier challenge ινδιψατεσ the population's understanding of long-term risks, including more frequent droughts and ecosystem stress, consistent with broader regional trends across Macaronesia.

The loss of natural water retention areas (mean 4.5), such as forests and wetlands, received the highest average concern. This response highlights a collective appreciation for the

ecological foundations of water regulation and suggests that respondents connect land degradation directly with hydrological instability. It also reveals an intuitive understanding of how deforestation or urban expansion can compromise natural storage and increase runoff, erosion, and water scarcity.

Concerns about groundwater depletion (mean 3.9) and saltwater intrusion (mean 4.1) were also high, indicating recognition of the fragility of coastal aquifers and the need for proactive management. The prominence of these issues reflects the island's dependence on subsurface storage and the growing awareness of saline intrusion risks associated with over-abstraction and sea-level rise. On the same note, flooding (mean 3.4) and high water costs (mean 3.3) provided more moderate concern. This pattern reflects spatial differentiation, while flooding is a recurrent hazard in certain low-lying or steep-slope areas, it is not perceived as a universal threat across the island. Similarly, water pricing is understood as a challenge but not the most acute issue when compared with environmental and climatic pressures.

Sustainable water supply for agriculture (mean 3.9) ranked among the top concerns, reinforcing the perceived importance of maintaining reliable irrigation and water resources to support rural livelihoods and food production. Agriculture remains a central component of Madeira's social and economic fabric, and this finding underscores awareness of the links between water availability, land management, and climate resilience.

Madeira respondents express a holistic and environmentally informed perception of water challenges. Their responses show that water scarcity, climate change, and ecological degradation are seen as interdependent threats requiring integrated management approaches. The prevalence of high ratings (means above 4 for most categories) demonstrates a population that is both aware of the urgency and receptive to interventions that combine technological, ecological, and community-based strategies.

This strong environmental awareness establishes favourable conditions for social acceptability of NBS. However, the emphasis on ecosystem loss and drought also signals a need for restoration-based approaches, particularly those reinforcing natural water retention, forest conservation, and aquifer recharge. The data suggest that public engagement in Madeira will be most effective when linked to visible ecological outcomes and climate adaptation narratives, rather than narrowly framed infrastructure or cost-oriented discussions.

7.4.3 Attitudes toward NBS

The survey results from Madeira reveal a consistently positive attitude toward NBS, grounded in strong environmental awareness and a belief in their potential to enhance water management and climate resilience. Respondents largely agree that NBS offer ecological and adaptive advantages over traditional infrastructure, though reservations persist regarding cost-effectiveness, feasibility, and maintenance.

Across the eleven evaluative statements, environmental and functional benefits dominate perceptions. Most respondents agreed or strongly agreed that NBS are effective for water storage (mean = 3.8), environmentally friendly (mean = 4.2), and provide multiple co-benefits such as biodiversity and recreation (mean = 4.1). Similarly, there was strong endorsement of their capacity to help communities adapt to climate change (mean = 4.1) and their appropriateness for Madeira's local climate and environment (mean = 3.9). These results confirm that NBS are widely understood as a credible and sustainable component of regional water management and climate adaptation strategies.

However, respondents also exhibited caution regarding implementation challenges. Only about half perceived NBS as cost-effective (mean = 3.4), while similar proportions expressed uncertainty about whether NBS require too much maintenance (mean = 3.6) or are difficult to implement (mean = 3.4) in the Madeiran context. These concerns are consistent with the island's topographic and spatial constraints, where land scarcity and steep terrain limit opportunities for large-scale ecological interventions. The presence of neutral responses across several items indicates that uncertainty, rather than opposition, underlies these perceptions, reflecting limited exposure to local demonstration projects rather than skepticism about NBS concepts themselves.

Respondents' views on integration and practicality were cautiously optimistic. Most participants agreed that NBS can complement traditional water management approaches (mean = 3.7), yet many noted that evidence of such integration remains limited. Meanwhile, a minority felt that NBS benefits may be overstated (mean = 3.1), suggesting a small pocket of skepticism likely tied to past experiences with project underperformance or communication gaps.

The ranking of perceived benefits reinforces the strong environmental orientation of Madeiran stakeholders. The most frequently cited advantages were improved water storage (65%), climate change adaptation (60%), biodiversity enhancement (55%), and improved water quality (50%). These priorities reveal that NBS are primarily valued for addressing ecological and hydrological risks, particularly drought and ecosystem degradation—issues already identified as top community concerns. Social and economic benefits, such as recreation, education, and job creation, were acknowledged but less prominent, suggesting that NBS are primarily viewed as environmental management instruments rather than socio-economic interventions.

Conversely, the list of perceived concerns demonstrates a strong focus on resource and capacity limitations rather than ideological resistance. The leading barriers were high implementation costs (61%), lack of technical expertise (57%), and maintenance requirements (52%). Secondary issues included uncertain effectiveness (40%), land availability constraints (35%), and regulatory or institutional barriers (25%). Notably, social resistance (10%) and nuisance risks (15%) were rarely cited, confirming that public acceptance is already strong. Instead, the obstacles identified are largely structural and operational, requiring targeted policy, funding, and training responses rather than attitude change.

Madeira respondents broadly support NBS and strongly endorse their environmental benefits and climate adaptation potential. However, compared with other regions, they show greater caution around feasibility and costs, with maintenance and technical expertise repeatedly cited as concerns. Benefits are primarily viewed in ecological terms, while practical capacity constraints are considered the main obstacles. This indicates that support is present but conditional, requiring investment in demonstration projects, technical training, and financial planning to build lasting confidence.

Thus, Madeira's population displays high environmental receptivity and conceptual trust in NBS, underpinned by concern for practical execution. With targeted technical support and visible demonstration of success, this positive perception base can be converted into sustained behavioural and policy acceptance, contributing directly to the long-term social acceptability framework envisioned in the GENESIS project.

7.4.4 Factors influencing acceptance

The Madeira survey results show a clear, evidence-based orientation toward NBS acceptance, with respondents prioritising scientific credibility, long-term sustainability, and environmental co-benefits as the most decisive motivators. Social and cultural considerations, as well as financial incentives, were viewed as secondary, while aesthetics and short-term outcomes had minimal influence. Trust in information sources followed a similar hierarchy: scientists and NGOs were the most trusted, whereas governmental and media sources were met with more caution.

Across the thirteen decision factors, long-term and knowledge-driven motivations dominated. The highest mean scores were recorded for long-term sustainability (mean = 4.4), environmental co-benefits (mean = 4.2), and scientific evidence of effectiveness (mean = 4.1). These findings confirm that the Madeiran public and stakeholders value NBS for their enduring, evidence-supported, and ecologically grounded advantages, aligning with the broader climate adaptation and ecosystem restoration narrative. Cost-effectiveness (mean = 3.7) and social co-benefits (mean = 3.7) were considered important, but with more balanced distributions across the rating scale, suggesting a nuanced perspective. Respondents recognise the value of NBS in delivering social and economic gains, yet they appear more focused on performance and sustainability than on cost reduction or immediate benefits. The lower scores for visual appeal (mean = 3.1) and short-term results (mean = 3.5) further reinforce long-term, substance-driven mindset that NBS are seen as strategic investments rather than aesthetic or short-lived projects.

The compatibility of NBS with local culture (mean = 3.6) and community involvement (mean = 3.9) were also rated positively, confirming that public participation and local relevance are recognised as key to success. However, cultural alignment was generally seen as contextual rather than decisive, indicating that technical credibility and ecological function carry greater weight in shaping acceptance. Similarly, support from community leaders (mean = 3.6) and financial incentives (mean = 3.6) were viewed as helpful but insufficient alone to influence acceptance without accompanying scientific and environmental justification.

The analysis of trust in information sources strengthens this interpretation. Scientists and researchers (mean = 4.1) and environmental NGOs (mean = 3.6) are the most trusted actors, followed closely by international organisations (mean = 3.6). This pattern suggests that credibility and perceived independence are key determinants of trust. Local and regional governments (means = 3.2 and 3.1) are viewed with moderate confidence, reflecting some skepticism about political consistency or implementation capacity. Water companies and agricultural organisations (means = 3.2–3.3) occupy a middle ground, trusted more than media but less than scientific institutions. In contrast, social media (mean = 2.2) and traditional media (mean = 2.6) are the least trusted channels, indicating that information campaigns should rely on expert-verified and institutional communication rather than mass media platforms.

This trust hierarchy has direct implications for governance and engagement strategies. Effective communication and mobilisation around NBS in Madeira will depend on leveraging scientific and NGO partnerships to build credibility, while strengthening institutional transparency and delivery at the government level.

The responses regarding preferred involvement in decision-making suggest a population that supports participatory approaches but favours consultation and information sharing over direct co-decision-making. Around 50% of respondents wished to be actively involved or consulted in planning and decision making, while 44% preferred to be kept informed without direct engagement. Only one respondent expressed no interest. This distribution

reflects a moderate participatory culture; one that values inclusion and transparency but may not yet have the institutional or social structures to sustain widespread active participation.

The Madeiran data indicate a technically minded and environmentally conscious public whose acceptance of NBS hinges on demonstrable performance, reliability, and expert credibility. The overall framework of acceptance can be summarised as "trust through evidence, engagement through transparency, and legitimacy through sustainability." The data point to a rational, pragmatic acceptance framework: NBS will gain social legitimacy in Madeira when backed by demonstrable evidence, tangible environmental impact, and assurances of long-term viability. Respondents show confidence in the concept of NBS, yet they expect proof of effectiveness and feasibility in the local context, consistent with the cautious optimism seen in earlier sections.

Scientists and researchers were the most trusted group, followed closely by environmental NGOs and international organisations. Local and regional governments were trusted at more moderate levels, with some skepticism. Water management companies and agricultural organisations attracted mixed Trust, while social and traditional media scored lowest, indicating that these channels are unlikely to be effective in building confidence. Local community organisations enjoyed relatively high trust, highlighting the value of community-based engagement.

Overall, Madeira respondents demonstrate a cautious but evidence-driven orientation toward NBS acceptance. They value rigorous proof, long-term outcomes, and credible messengers, while showing limited reliance on aesthetic appeal or subsidies. Building acceptance in this context will require a science-led, participatory approach, supported by transparent communication and demonstration of practical feasibility.To consolidate this foundation, future policy and project design should:

1. Prioritise scientific validation and transparent monitoring of NBS performance to sustain credibility.
2. Integrate NGOs and researchers as trusted intermediaries between authorities and communities.
3. Offer consultative engagement formats that inform and involve citizens without overburdening them with technical decision-making.
4. Develop cost–benefit communication materials that clarify long-term economic and environmental gains relative to conventional infrastructure.

This evidence-based, trust-oriented orientation positions Madeira as a region with high potential for informed, cooperative NBS governance, provided that scientific credibility and sustained communication remain central to implementation strategies.

7.4.5 Implementation and governance

The findings from Madeira reveal a pragmatic and implementation-oriented perspective on how to advance NBS. Respondents clearly support the concept of NBS and view them as environmentally necessary; however, they emphasise that demonstration, technical capacity, and institutional leadership are prerequisites for success. Public acceptance is not perceived as a major barrier. The challenge lies in turning support into practice through well-resourced, visible, and coordinated action.

Approaches to increase acceptance point strongly toward experiential and participatory learning. The most frequently chosen strategies were pilot or demonstration projects

(63%), community workshops and consultations (56%), and public education campaigns (50%). These preferences suggest that Madeiran respondents value seeing NBS in action and participating in collective dialogue about their benefits and feasibility. Similarly, site visits to successful projects (44%) and involving residents in design and planning (38%) were highlighted as effective methods for reinforcing confidence. The selection of transparent cost–benefit analysis (38%) indicates a desire for openness and accountability in investment decisions.

By contrast, financial incentives (19%) and traditional ecological knowledge (13%) were less frequently chosen, suggesting that while they may complement acceptance efforts, they are not perceived as central mechanisms in the Madeiran context. Citizens prioritise evidence, engagement, and visibility over monetary or heritage-based incentives.

When identifying responsible actors for NBS implementation and maintenance, respondents overwhelmingly pointed to governmental leadership. Local government (63%) and regional/national government (50%) were seen as the primary institutions responsible for both planning and execution, indicating trust in institutional coordination and expectations of public accountability. Environmental NGOs (38%) and public–private partnerships (31%) were seen as complementary actors, essential for expertise and outreach but not as the principal drivers. In contrast, community organisations (25%), water management companies (25%), and property owners (13%) were less frequently cited, signalling a clear preference for institutional rather than individual responsibility. This governance pattern suggests that while Madeira's public is open to collaboration; specifically, the public expects government entities to lead and finance the transition toward sustainable water and land management.

The assessment of barriers to implementation reinforces the structural and operational focus identified throughout the survey. The top challenges were financial or resource limitations (69%), lack of technical expertise (56%), and institutional or political barriers (44%), indicating that the key obstacles are capacity-related rather than attitudinal. Regulatory and legal barriers (31%) and land availability constraints (25%) were also noted, reflecting Madeira's limited developable space and complex administrative environment. In contrast, social or cultural resistance (13%), lack of awareness (13%), and climatic or geographic constraints (6%) were rarely mentioned, confirming that social acceptance already exists and that the perceived gaps lie in resources, governance, and technical delivery.

Madeira respondents see the path to successful NBS adoption as rooted in visible demonstration, participatory processes, and strong institutional leadership. They expect local and national governments to take the lead, supported by NGOs, partnerships, and community organisations. The key barriers are not cultural but structural. A lack of financial resources, technical expertise, and governance capacity. Acceptance strategies should therefore prioritise pilot projects, transparent communication, and capacity-building, while ensuring that institutional frameworks are prepared to sustain implementation.

The data depicts a technically supportive but institutionally cautious landscape. Citizens and stakeholders in Madeira largely endorse NBS but recognise that successful implementation requires:

1. Visible pilot projects that demonstrate local feasibility and cost-effectiveness,
2. Government-led coordination, supported by NGOs and technical experts,
3. Investment in capacity building, training, and resource mobilisation to overcome structural barriers.

The overall pattern aligns with the regional findings across Macaronesia: acceptance is strong in principle, but institutionalisation remains dependent on governance readiness and resource allocation. In Madeira's case, the combination of high awareness, trust in science, and moderate expectations of participation provides a strong foundation for progress, provided that governance mechanisms evolve toward inclusive, evidence-based, and transparent implementation.

7.4.6 Additional comments

The open-text feedback and participation preferences from Madeira reinforce the broad support for NBS that coexists with pragmatic awareness of technical and financial limitations. Respondents display a forward-looking attitude, recognising NBS as essential for environmental protection and climate resilience, while simultaneously highlighting the need for education, demonstration, and institutional capacity-building to ensure effective implementation.

Several respondents voiced explicit support for ecological and sustainable approaches to managing water resources, reflecting an alignment between public perception and the GENESIS project's objectives. Comments frequently mentioned the need for technical expertise and sustainable funding mechanisms, indicating that stakeholders view practical execution and cost management as critical bottlenecks. Respondents emphasised the importance of awareness campaigns, particularly targeting schools and youth, as essential for building long-term understanding and intergenerational commitment to sustainability. NBS were consistently recognised as tools for enhancing adaptation to climate impacts and for protecting Madeira's fragile ecosystems from drought, erosion, and biodiversity loss.

The aforementioned support the notion that social acceptance of NBS in Madeira is anchored in environmental awareness and generational learning, while doubts persist about the adequacy of funding and local technical capacity. Respondents appear optimistic yet grounded, aware that good intentions must be matched by institutional delivery and local expertise.

Regarding future participation, engagement willingness is remarkably high. The most preferred activities were workshops or public meetings (63%), site visits to demonstration projects (56%), and citizen science monitoring (50%). These preferences reveal an appetite for interactive, experience-based, and community-level involvement. They align closely with earlier findings on the value placed on demonstration and transparency as pathways to strengthen trust.

A smaller but still notable portion of respondents expressed interest in further surveys or research (38%), showing continued curiosity and willingness to contribute to data-driven processes. Additionally, nearly one-fifth (19%) indicated readiness to host pilot projects on their property, a significant indicator of active ownership and behavioural acceptance beyond theoretical support. Only one participant (6%) stated disinterest in future participation, confirming that the Madeiran community is generally receptive and willing to engage in the co-design and implementation of NBS.

The additional comments and activity preferences demonstrate a clear readiness for engagement among Madeira respondents. They want to learn, participate, and even collaborate in hands-on demonstrations, but they are also aware of the barriers to implementation. Education, transparency, and visible examples will be crucial in maintaining momentum and addressing lingering concerns about feasibility and resources.

The combined qualitative and quantitative results illustrate a mature and constructive public perspective: stakeholders understand the challenges and opportunities of implementing NBS and express both confidence and responsibility in contributing to the process. Their emphasis on education, demonstration, and transparent governance reaffirms that social acceptability in Madeira is not passive endorsement but informed, conditional support. This can be seen from the positive light of being strengthened through continuous engagement and shared learning. From a governance and policy standpoint, these insights suggest several actionable implications for the Madeira demonstrator and broader regional strategy:

1. Invest in visible pilot projects to build credibility and maintain engagement momentum.
2. Expand environmental education programmes, especially targeting schools and youth networks, to sustain generational awareness.
3. Maintain participatory dialogue mechanisms (workshops, citizen science, and feedback platforms) to keep stakeholders informed and connected to outcomes.
4. Address funding and technical capacity gaps through institutional partnerships and targeted training, ensuring that public enthusiasm translates into successful implementation.

Madeira's survey participants demonstrate a well-informed, environmentally conscious, and engagement-ready profile. Their support for NBS is genuine and forward-looking but contingent upon governance reliability, technical feasibility, and continued communication. This pragmatic optimism provides a strong social foundation for the GENESIS demonstrator's long-term success and for the operationalisation of the Water Governance Framework of Social Acceptability.

7.4.7 Statistical analysis of Madeira survey data

Across all sections of the survey, Cape Verde respondents expressed high concern about water challenges, moderate awareness of NBS, and cautious but positive attitudes. For awareness and knowledge, the mean familiarity score was 2.6 on a 4-point scale. Around 55% reported being somewhat or very familiar, while 20% had little or no prior awareness. Half rated their understanding as good or very good.

For water challenges, the overall mean concern level across the ten categories was 4.0 (SD ~ 0.6), which is well above the neutral midpoint of 3. The strongest concerns were for water scarcity (mean 4.5, median 5), climate change impacts (mean 4.4, median 5), and loss of natural retention areas (mean 4.5, median 5). High water costs (mean 3.3, median 3) and flooding (mean 3.4, median 3) received lower scores. For attitudes toward NBS the average agreement across the 11 statements was 3.8 (SD ≈ 0.7). The highest means were for environmental friendliness (4.2) and climate adaptation (4.1), while cost-effectiveness (3.4) and maintenance (3.6) were more mixed. For decision factors the overall mean across 13 items was 3.8 (SD ~ 0.6). Long-term sustainability (4.4) was the highest-rated factor, followed by environmental co-benefits (4.2) and scientific evidence (4.1). The lowest were visual appeal (3.2) and short-term results (3.5). For Trust in sources the overall mean was 3.4 (SD ~ 0.8). Trust was highest for scientists (4.2) and NGOs (3.9), moderate for government (3.2–3.3), and lowest for social media (2.1) and traditional media (2.6). For participation willingness, 70% expressed interest in workshops, 65% in site visits, 61% in citizen science, and 22% in pilot projects on private property. Only one respondent (≈4%) reported no interest.

For water challenges, one-sample t-tests showed that mean scores for water scarcity (4.3), climate impacts (4.4), water quality (4.2), saltwater intrusion (4.1), and loss of retention areas (4.5) were all significantly higher than neutral (3), with $p < 0.001$. Flooding (3.4) and high water costs (3.3) did not differ significantly from neutrality ($p > 0.05$).

For decision factors, paired t-tests confirmed that environmental co-benefits (4.2) were rated significantly higher than visual appeal (3.1) ($t \approx 7.0$, $p < 0.001$). Long-term sustainability (4.4) was rated significantly higher than short-term results (3.5) ($t \approx 8.4$, $p < 0.001$), confirming that respondents strongly prioritise longevity.

For attitudes toward NBS, the statements on environmental friendliness (4.2) and climate adaptation (4.1) were rated significantly higher than neutrality ($p < 0.001$). The statement "NBS benefits have been overstated" (3.1) was not significantly different from neutrality, indicating mild skepticism.

For Trust in sources, Trust in scientists (4.1) was significantly higher than in traditional media (2.6) and social media (2.2) ($p < 0.001$). Trust in NGOs (3.6) was also significantly higher than in government (≈3.1–3.2) ($p < 0.05$). Exploratory correlations provided further insight into drivers of acceptance:

- Trust in scientists correlated with belief in NBS effectiveness ($r \sim 0.5$, $p < 0.01$),
- Trust in NGOs correlated moderately with willingness to participate in citizen science ($r \sim 0.4$, $p < 0.05$),
- Concern about climate change impacts correlated with agreement that NBS support adaptation ($r \sim 0.6$, $p < 0.01$).

The statistical evidence reinforces and strengthens the descriptive findings. Concern is widespread and significant. For nearly all water challenges, mean levels were significantly above neutral. The ecological and climate-related risks are especially urgent, particularly scarcity and retention loss. Acceptance is evidence-driven. Scientific credibility, sustainability, and environmental benefits were rated significantly higher than aesthetics or short-term results. Trust is decisive, with high trust in scientists and NGOs being directly linked to positive attitudes toward NBS, while trust in NGOs also predicts willingness to participate.

Barriers are structural, not cultural. The results confirm that cultural resistance is minimal. Instead, resources, technical expertise, and institutional support are the main obstacles.

The statistical analysis confirms that support for NBS in Madeira is positive but cautious. Respondents' concerns and attitudes are consistent, significantly different from neutrality, and strongly influenced by trust and evidence. Communities see NBS as credible and aligned with their environmental priorities, but also emphasise doubts about feasibility, costs, and maintenance.

Madeira offers a statistically robust yet conditional foundation for NBS implementation, with public support grounded in scientific credibility, long-term sustainability, and environmental priorities. Success will depend on addressing financial and technical barriers, as well as building confidence in the cost-effectiveness and practicality of locally adapted demonstration projects.

7.4.8 Overall survey synthesis for Madeira

The survey of respondents in Madeira (N = 16) provides an insightful picture of how local stakeholders perceive and value NBS in the context of water management. The results

confirm a community that is environmentally conscious and broadly supportive of NBS, but also cautious about their practical implementation, costs, and long-term feasibility.

Awareness of NBS in Madeira is moderate. Most respondents had at least some familiarity, and half rated their understanding as good or very good. The solutions most often recognised were ecological measures such as watershed reforestation and aquifer recharge, which align closely with the island's environmental setting. Urban and engineered interventions like green roofs and permeable pavements were less commonly encountered, reflecting their limited application in the local context.

Water challenges are perceived as pressing and multifaceted. Respondents expressed strong concern about water scarcity, climate change impacts, and the loss of natural retention areas, with mean scores well above 4 on a 5-point scale. Concerns about water quality and ageing infrastructure were also high, while economic factors such as high water costs and flooding were seen as somewhat less urgent. These findings illustrate that climate and ecosystem vulnerabilities are central to Madeira's water security concerns, overshadowing purely economic issues.

Attitudes toward NBS are largely positive, with strong endorsement of their environmental friendliness, multifunctionality, and potential to support climate adaptation. Azores and Canary Islands respondents expressed confidence in the environmental and climate-related benefits of NBS but retained doubts about cost-effectiveness and long-term maintenance. Cape Verde respondents were more cautious overall. While supportive of NBS in principle, they expressed higher levels of neutrality or disagreement on feasibility statements, such as implementation difficulty, space requirements, and maintenance burdens. This reflects the reality of limited land, financial resources, and technical capacity in the archipelago. Madeira respondents also displayed caution, particularly around institutional readiness. They emphasised that NBS must be technically and financially viable and backed by clear governance structures. Compared to the Canaries, where enthusiasm was stronger, Madeira's tone was more reserved and conditional.

The analysis of decision factors confirms this pattern. Respondents placed the highest importance on scientific evidence, long-term sustainability, and environmental co-benefits, while visual appeal and short-term results were ranked lowest. Trust in information sources followed a similar evidence-driven orientation, with scientists and NGOs rated as most highly, governments as moderately, and media channels as least trusted. This reinforces the finding that support for NBS in Madeira depends on credible, science-based communication and demonstrable proof of effectiveness.

Implementation and governance preferences highlight a pragmatic orientation. Respondents favoured pilot projects, community workshops, and education campaigns as the most effective ways to build acceptance, and they expect local and national governments to lead implementation. Barriers were identified primarily as financial, technical, and institutional, with cultural resistance or lack of awareness playing a minimal role. In the Azores, Canaries, and Madeira, respondents strongly expect local and national governments to lead the implementation and maintenance of NBS. NGOs, community organisations, and public-private partnerships are seen as supportive but secondary actors. In Cape Verde, while government leadership is also expected, there is a stronger recognition of the need for external technical guidance and international support. This aligns with the perception of resource and expertise constraints, as well as the role of external donors in Cape Verde's environmental programmes. In all regions, respondents placed little responsibility on private property owners, signalling that NBS are seen as a collective and institutional responsibility rather than an individual one.

Open comments and future participation preferences reinforce these themes. Respondents expressed enthusiasm for NBS, particularly as tools for climate adaptation and ecological protection, but also raised concerns about costs and governance bottlenecks. The majority expressed interest in participating in workshops, site visits, and citizen science, with a smaller group willing to host pilot projects on their property. This demonstrates a community that is open to engagement and eager to contribute, provided that institutional support is strong. Canary Islands respondents showed the strongest enthusiasm for hands-on engagement, with very high willingness to participate in workshops, citizen science, and even pilot projects on private property. This reflects both the larger sample size and a strong participatory culture. Azores respondents also expressed strong readiness to engage, particularly through citizen science and monitoring activities, though fewer indicated willingness to host pilots. Cape Verde respondents were supportive but more conditional, linking participation to clearer communication, technical training, and institutional backing. Their willingness is evident, but on the condition that projects are practical and supported. Madeira data results depict a community that is supportive but cautious. Respondents recognise the urgency of water challenges and view NBS as credible solutions, but their acceptance is conditional on technical feasibility, financial sustainability, and effective governance. With credible science, transparent communication, and visible demonstration projects, Madeira has the potential to become a strong showcase for NBS in island contexts. However, success will depend on mobilising resources, building capacity, and ensuring institutional leadership to overcome the structural barriers identified in the survey.

8 Cross-Regional Comparative Analysis

This chapter synthesises empirical evidence to identify regional commonalities that enable knowledge transfer and coordinated approaches, while highlighting key differences that demand context-specific adaptation. Understanding where regions align and where they diverge is essential for tailoring the governance models presented in Chapter 10 to local realities while maintaining coherence across Macaronesian collaborative initiatives.

8.1 Regional commonalities

8.1.1 Strong conceptual support for NBS

Across all four regions, stakeholder surveys and interviews revealed consistently high levels of conceptual support for nature-based solutions as appropriate responses to water challenges. Over 70% of respondents in each archipelago viewed NBS as environmentally sound, technically feasible, and culturally compatible with local values and practices. This convergence indicates that the fundamental premise of ecosystem-based water management resonates broadly across diverse Macaronesian contexts.

The consistency of support spans institutional categories, with government officials, technical professionals, agricultural producers, civil society representatives, and general citizens expressing similar levels of endorsement. This cross-sectoral alignment creates favourable conditions for collaborative governance, as stakeholder groups share baseline agreement about the legitimacy of NBS approaches even where they may differ on implementation priorities or specific project designs.

Importantly, support is not merely abstract endorsement but reflects practical recognition of water challenges requiring innovative responses. Climate change impacts, increasing water demand, aquifer depletion, and extreme weather events were identified as serious concerns across all islands, with NBS seen as essential components of comprehensive adaptation strategies rather than optional enhancements to conventional infrastructure.

8.1.2 Trust in scientific and civil society actors

Scientists, researchers, and environmental NGOs emerged as the most trusted sources of information and guidance regarding water management and NBS across all regions. This pattern held consistently despite variations in institutional contexts, suggesting that scientific credibility and perceived independence from political or commercial interests create legitimacy that government agencies and private sector actors often lack.

The high trust in scientific actors creates strategic opportunities for governance design. Positioning researchers and NGOs as facilitators, mediators, and knowledge brokers within participatory processes can leverage this credibility to build confidence in NBS, bridge technical expertise and local knowledge, mediate conflicts between stakeholder groups, and enhance transparency through independent monitoring and evaluation.

Conversely, the data suggest that purely top-down, government-led implementation approaches may struggle to achieve social legitimacy even when technically sound. Effective governance requires integration of trusted actors into decision-making processes rather than relegating them to peripheral advisory roles.

8.1.3 Financial constraints as the primary barrier

Financial and resource limitations were identified as the most significant implementation barrier in all four regions, though with varying intensity (discussed in Section 9.2). The consistency of this finding across diverse economic contexts—from relatively affluent Madeira and the Canaries to resource-constrained Cape Verde—indicates that NBS financing represents a systematic challenge requiring attention regardless of overall fiscal capacity.

Stakeholders consistently noted that existing public budgets prioritise immediate service delivery and conventional infrastructure, with limited fiscal space for innovative approaches perceived as higher-risk or delivering benefits over longer timeframes. The absence of established financing mechanisms specifically designed for NBS—such as dedicated funds, payment for ecosystem services schemes, or green infrastructure bonds—creates structural impediments to implementation even where political will and technical capacity exist.

This commonality suggests that regional or Macaronesia-wide initiatives to develop financing frameworks, coordinate access to EU funding programmes, and establish economic valuation methodologies could provide high-leverage interventions benefiting all archipelagos.

8.1.4 Institutional fragmentation and coordination challenges

Governance fragmentation emerged as a consistent obstacle across all regions, with water management responsibilities distributed among multiple agencies covering surface water, groundwater, environmental protection, agriculture, spatial planning, and infrastructure. This institutional complexity creates coordination challenges, approval delays, jurisdictional ambiguities, and missed opportunities for integrated approaches.

The pattern reflects broader characteristics of public administration in island contexts, where limited human resources must cover diverse functional areas while reporting to multiple levels of government (municipal, island, regional, national, and EU). While the specific institutional architectures differ between Portuguese, Spanish, and Cape Verdean administrative frameworks, the fundamental challenge of achieving effective coordination across fragmented responsibilities is universal.

This commonality reinforces the importance of coordination mechanisms embedded within the governance models presented in Chapter 8, particularly the Multi-Stakeholder Platform approach designed explicitly to bridge institutional silos through structured collaboration.

8.1.5 Cultural compatibility and heritage connections

Across all archipelagos, NBS were viewed as compatible with—and in many cases, continuous with—traditional water management practices rooted in agricultural heritage and adaptive resource stewardship. Historical approaches such as rainwater harvesting, terracing, check dams, and strategic vegetation management align conceptually with contemporary NBS frameworks, creating opportunities to frame modern interventions as recovery or modernisation of ancestral wisdom.

This cultural compatibility represents a significant asset differentiating Macaronesia from some continental European contexts where NBS may be perceived as novel impositions disrupting established practices. The potential to leverage heritage connections for social

legitimacy, community engagement, and intergenerational knowledge transfer emerged consistently across stakeholder consultations.

Regional initiatives to document traditional ecological knowledge, validate historical practices through contemporary monitoring, and integrate ancestral approaches into demonstration projects could strengthen this common foundation while honouring cultural diversity across archipelagos.

8.2 Key differences by region

8.2.1 Economic capacity and resource availability

While financial constraints represent a common barrier, the intensity and nature of resource limitations vary substantially across regions. Cape Verde, as an independent developing nation, faces the most acute constraints, with 70% of survey respondents identifying finances as a critical barrier and interview participants emphasising the need for modular, low-cost approaches compatible with limited public budgets and infrastructure capacity.

Madeira and the Azores, as Portuguese autonomous regions within the EU, access structural funds and cohesion programmes providing resources unavailable to Cape Verde. However, 69% of Madeiran respondents still cited finances as a major concern, indicating that even relatively well-resourced EU regions struggle with NBS financing given competing priorities and the absence of dedicated mechanisms.

The Canary Islands, as a Spanish autonomous community, occupy an intermediate position with access to EU and national funding but facing constraints from economic dependence on tourism and limited fiscal autonomy. Approximately 54% of Canarian respondents identified financial barriers, the lowest proportion among the four regions, but still representing a majority concern.

These differences have strategic implications. Cape Verde requires international development assistance, technical cooperation, and South-South knowledge exchange to overcome resource constraints. Portuguese regions can leverage EU structural funds, though the capacity for proposal development and co-financing remains limited. The Canaries may benefit from integration with Spanish national water programmes and innovation funding.

8.2.2 Institutional capacity and governance maturity

Institutional capacity for NBS implementation varies substantially across regions, reflecting differences in administrative infrastructure, professional staffing, and governance sophistication.

The Canary Islands demonstrated the most developed institutional capacity, with established water authorities (Consejos Insulares de Aguas), extensive hydrogeological monitoring networks, active research institutions, and significant prior experience with innovative water management, including desalination, wastewater reuse, and aquifer recharge experiments. However, stakeholders noted that this institutional complexity also creates coordination challenges, with multiple agencies operating relatively independently.

Madeira exhibits strong environmental governance frameworks and technical capacity within regional authorities, but faces challenges in municipal-level implementation where

smaller administrative units lack specialised staff. Interview participants emphasised the need to strengthen municipal capacity while maintaining regional coordination and oversight.

The Azores benefit from relatively cohesive regional governance and strong environmental identity, but have limited prior experience specifically with managed aquifer recharge and infiltration-based NBS. Stakeholders expressed enthusiasm for landscape-scale approaches—particularly reforestation and watershed restoration—where existing capacity and cultural affinity are stronger.

Cape Verde faces the most significant institutional capacity constraints, with limited numbers of specialised professionals, nascent monitoring infrastructure, and governance systems still evolving. However, respondents demonstrated sophisticated understanding of challenges and opportunities, suggesting that targeted capacity development could rapidly enhance implementation readiness.

8.2.3 Public awareness and environmental consciousness

Public awareness of water challenges and NBS concepts varies across regions in ways that influence engagement strategies and governance approaches.

The Azores exhibited the highest environmental consciousness, with strong public identification with landscape preservation, cultural connections to agricultural and pastoral traditions, and active civil society engagement on environmental issues. This creates favourable conditions for community-based co-management approaches leveraging existing social capital and environmental stewardship ethics.

Madeira demonstrated high awareness of water scarcity and climate vulnerability, driven by recent droughts and water restrictions affecting tourism and agriculture. This acute awareness of challenges creates openness to innovative solutions, though technical understanding of NBS mechanisms remains limited outside specialist communities.

The Canary Islands showed variable awareness, with high consciousness in rural and agricultural communities historically engaged in water management, but lower awareness in urban populations accustomed to a more reliable piped supply. This geographic variation suggests the need for differentiated engagement strategies across urban and rural contexts.

Cape Verde exhibited pragmatic awareness focused on immediate water security challenges—drought, aquifer depletion, salinisation—with strong interest in practical solutions but limited exposure to NBS terminology and concepts. Educational approaches should emphasise tangible benefits and connections to traditional practices rather than technical frameworks.

8.2.4 Dominant water challenges and NBS priorities

While all regions face water security challenges, the specific priorities and dominant concerns differ in ways that should inform NBS portfolio selection and sequencing.

Azores: climate impacts, loss of natural retention areas, and maintaining ecological water quality emerged as primary concerns. Priorities include watershed reforestation, wetland restoration, and landscape-scale infiltration enhancement integrated with agricultural and conservation objectives. Flooding and extreme rainfall events are also significant concerns requiring attention to runoff management.

Canary Islands: aquifer overexploitation, seawater intrusion, and declining water quality represent critical challenges driving interest in managed aquifer recharge, particularly through surface infiltration basins and streambed modifications. Institutional fragmentation and coordination gaps were emphasised as governance priorities requiring attention alongside technical interventions.

Madeira: Water scarcity, particularly during summer months, affecting tourism and agriculture, dominated stakeholder concerns alongside ecosystem degradation and climate vulnerability. Priorities include infiltration enhancement, rainwater harvesting, and formal strengthening of governance and financing mechanisms to enable systematic implementation.

Cape Verde: extreme water scarcity driven by low rainfall, high evaporation, and limited storage capacity creates existential challenges. Priorities emphasise soil water retention, erosion control, groundwater recharge in suitable geological settings, and modular approaches compatible with resource constraints. Traditional knowledge integration and community-based management align well with social structures and capacity realities.

8.2.5 Regulatory and political contexts

The four regions operate under fundamentally different political and regulatory frameworks, shaping governance possibilities and constraints.

Portuguese Autonomous Regions (Azores, Madeira): Operate under Portuguese national legislation and EU directives with regional autonomy for environmental and water management. Strong legal frameworks exist but may require adaptation to explicitly accommodate NBS. Regional governments have substantial authority but remain accountable to national oversight and EU standards.

Spanish Autonomous Community (Canary Islands): Functions within Spanish water law and EU frameworks with significant autonomy but also complexity from overlapping jurisdictions between regional (Comunidad Autónoma), island (Cabildo Insular), and municipal authorities. Well-developed legal structures exist, but coordination across governance levels presents challenges.

Independent Nation (Cape Verde): Operates under national sovereignty with full legislative authority but without direct EU integration or access to EU structural programmes. Greater flexibility for regulatory innovation, but also greater responsibility for developing frameworks without established templates. International development partnerships and bilateral cooperation provide alternative support mechanisms.

These differences necessitate tailored approaches to legal and regulatory integration while maintaining potential for inter-regional learning and coordination where beneficial.

8.3 Comparative assessment framework

To synthesise these commonalities and differences, Table 8.1 presents a comparative assessment across key dimensions relevant to NBS governance and implementation.

Table 8.1: Comparative assessment of regional contexts for NBS implementation.

Dimension	Azores	Canary Islands	Madeira	Cape Verde
Economic Capacity	Moderate-High (EU region)	Moderate (EU region, tourism-dependent)	Moderate-High (EU region)	Low (Developing nation)
Institutional Capacity	Moderate (Limited MAR experience)	High (Established water authorities)	Moderate-High (Strong regional, weak municipal)	Low (Capacity constraints)
Public Awareness	High (Strong environmental identity)	Variable (Urban-rural divide)	Moderate-High (Drought-driven)	Moderate (Pragmatic, challenge-focused)
Governance Complexity	Low-Moderate (Cohesive regional)	High (Multi-level fragmentation)	Moderate (Regional-municipal coordination)	Moderate (Evolving frameworks)
Primary Water Challenge	Climate impacts, retention loss	Aquifer overexploitation	Water scarcity (seasonal)	Extreme scarcity, drought
Cultural Compatibility	Very High (Heritage connection)	High (Traditional practices)	High (Agricultural heritage)	Very High (Ancestral knowledge)
Financial Barrier Intensity	Moderate (52% concerned)	Moderate (54% concerned)	High (69% concerned)	Very High (70% concerned)
Priority NBS Types	Reforestation, wetlands, landscape	MAR, infiltration basins	Rainwater harvesting, infiltration	Soil retention, erosion control, traditional systems
Recommended Governance Model	Community Co-Management	Multi-Stakeholder Platform	Hybrid (Regional MSP + Local Co-Management)	Community Co-Management with Adaptive Learning
Implementation Readiness	Moderate-High (Strong social capital)	High (Technical capacity,	Moderate (Financing and	Low-Moderate (Capacity

Dimension	Azores	Canary Islands	Madeira	Cape Verde
		coordination needed)	municipal capacity gaps)	building priority)

8.4 Implications for governance design

8.4.1 Differentiated implementation pathways

While financial constraints represent a common barrier, the intensity and nature of resource limitations vary substantially across regions. Cape Verde, as an independent developing nation, faces the most acute constraints, with 70% of survey respondents identifying finances as a critical barrier and interview participants emphasising the need for modular, low-cost approaches compatible with limited public budgets and infrastructure capacity.

Azores should prioritise community-based co-management approaches leveraging strong environmental consciousness, social capital, and cultural connections to landscape stewardship. Demonstration projects integrating reforestation, wetland restoration, and infiltration enhancement with participatory monitoring can build on existing community engagement strengths while developing technical capacity through learning-by-doing.

Canary Islands require multi-stakeholder platforms to address institutional fragmentation and coordinate across multiple agencies and governance levels. Technical capacity is sufficient to support sophisticated NBS design, but governance innovation is needed to overcome coordination barriers and align sectoral policies. Regional learning networks connecting islands can facilitate knowledge exchange while respecting insular autonomy.

Madeira benefits from hybrid approaches combining regional-level multi-stakeholder platforms for strategic coordination and financing with municipal-level community co-management for site-specific implementation. Strengthening municipal capacity through training, technical support, and clear regional guidance can overcome current implementation bottlenecks while maintaining democratic accountability and local adaptation.

Cape Verde should emphasise adaptive collaborative governance that embraces uncertainty, builds capacity through structured learning, and integrates traditional ecological knowledge with contemporary science. Modular, low-cost demonstration projects designed as learning platforms can simultaneously test NBS performance, develop local expertise, and build institutional frameworks through iterative experience rather than attempting comprehensive planning with limited baseline capacity.

8.4.2 Opportunities for inter-regional collaboration

Despite differences, several opportunities for productive collaboration across regions emerge from the analysis:

- Shared financing mechanisms, collaborative proposals to EU programmes (LIFE, Cohesion Fund, Horizon Europe) combining expertise and experience from multiple regions may access larger funding pools than individual regional applications, while enabling comparative learning.

- Technical knowledge exchange, establishing a Macaronesia NBS Knowledge Network connecting researchers, practitioners, and managers across archipelagos can facilitate the transfer of lessons learned, sharing of monitoring data, joint protocol development, and peer learning that accelerates progress beyond what isolated regional efforts could achieve.
- Demonstration project coordination, strategic coordination of demonstration site selection across regions to test NBS performance under different climatic, hydrogeological, and institutional conditions generates comparative data valuable to all participants while avoiding duplication of limited resources.
- Capacity building programmes, joint training initiatives, professional exchanges, and communities of practice can achieve economies of scale and expose participants to diverse approaches, building Macaronesia-wide expertise that transcends individual regional capacities.
- Political advocacy, coordinated engagement with EU institutions, national governments, and international development agencies on NBS financing, regulatory frameworks, and technical standards can amplify regional voices and secure greater attention and resources than fragmented advocacy.

8.4.3 Synthesis: unity in diversity

The cross-regional comparative analysis reveals Macaronesia as simultaneously unified and diverse. Common challenges, financial constraints, institutional fragmentation, climate vulnerability, create shared interests in collaborative solutions and knowledge exchange. Common assets—cultural compatibility with NBS, trust in scientific actors, strong environmental values—provide a foundation for participatory governance approaches across all regions.

Yet critical differences in economic capacity, institutional maturity, governance complexity, and dominant water challenges demand contextually adapted implementation strategies. The governance framework presented in Chapter 8 provides a flexible architecture accommodating this diversity through multiple models and hybrid configurations, while the barriers and opportunities synthesis (Chapter 10) identifies leverage points applicable across regions despite varying manifestations.

Successful NBS advancement in Macaronesia requires embracing both unity and diversity: coordinating where collaboration adds value, learning from each other's experiences and innovations, sharing resources and expertise across archipelagos, while simultaneously respecting contextual differences, adapting approaches to local realities, and empowering regional and local decision-making. The governance models and strategic recommendations presented in this report provide frameworks for achieving this balance, supporting Macaronesian islands in becoming international exemplars of participatory, ecosystem-based approaches to water security and climate resilience.

9 Barriers and opportunities

Across the four Macaronesian regions, Azores, Canary Islands, Madeira, and Cape Verde, citizens expressed strong conceptual and practical support for NBS as key instruments to address water scarcity, saline intrusion, and the impacts of climate change, which presents the opportunity for implementation. Survey and interview data reveal that while the awareness and endorsement of NBS principles are widespread, confidence in their implementation and sustainability is uneven across regions. This divergence is largely shaped by variations in governance capacity, availability of technical expertise, and access to financial resources, which in essence present the barriers for implementation. This chapter utilises inferences made from data discussed in previous chapters.

9.1 Stakeholder perceived barriers and challenges

The data from the the interviews and the survey investigation for the barriers to NBS section, revealed that responce across all regions consistently emphasised financial/resource limitations, institutional/political bottlenecks, and technical expertise gaps. Social or cultural resistance, aesthetic objections, and lack of public acceptance were rarely high in their priorities. This convergence is significant and demonstrates that opposition to NBS is not rooted in community resistance but in systemic and structural challenges. The public is largely supportive, but funding, capacity, and governance conditions are not yet sufficient or mature enough to realise full implementation. Below the barriers and challenges identified during the interviews and surveys are further analysed to provide structural insights and identify practical ways to address them.

9.1.1 Financial and resource constraints

Financial and resource limitations emerged as the single most critical barrier across all four regions. Cape Verde (70% of respondents) and Madeira (69%) registered the highest levels of concern, followed by the Canary Islands (54%) and the Azores (52%). Respondents consistently mentioned that small-island economies operate under constrained public budgets where immediate infrastructure or service needs take precedence over long-term ecological investments.

The financial burden associated with NBS design, construction, maintenance, and monitoring was highlighted as particularly problematic in contexts where conventional grey infrastructure remains the dominant investment model. Municipal and regional governments face competing demands for education, health, transport, and direct water supply infrastructure, with limited fiscal space for innovative approaches perceived as higher-risk. The absence of dedicated financing streams specifically for NBS, combined with lack of cost-sharing mechanisms between beneficiaries, has slowed implementation even where political will exists.

Interview respondents in Cape Verde and Madeira emphasised that project proposals struggle to secure approval when economic valuations capture only direct water supply benefits while ignoring co-benefits such as biodiversity enhancement, recreation, landscape amenity, and cultural services. Without frameworks for monetising or otherwise accounting for these multiple benefits, NBS appear less cost-effective than they actually are when comprehensive value propositions are considered.

The findings point to a systemic gap in financing architecture. Even strong community and institutional support cannot translate into implementation without viable funding pathways. Future efforts must prioritise blended financing integrating public-private partnerships, EU structural funds (Cohesion Fund, LIFE Programme), and local co-financing mechanisms to bridge the gap between intent and practice.

9.1.2 Technical and institutional capacity

The second most consistent barrier relates to technical and institutional readiness. Over half of respondents across all regions indicated that expertise required to design, implement, and monitor NBS remains insufficient. This constraint was particularly emphasised in Cape Verde, Madeira, and the Azores, where respondents called for targeted capacity-building initiatives for engineers, planners, and municipal technicians.

Stakeholders noted that professional training in water sector institutions has historically focused on conventional infrastructure, creating knowledge gaps in ecological engineering, soil-water-vegetation dynamics, and ecosystem service assessment. While universities in Portugal and Spain offer relevant academic programmes, translating research knowledge into operational capacity within implementing agencies requires sustained investment in professional development, technical guidance materials, and mentoring programmes.

In the Canary Islands, the issue was framed more as institutional than purely technical. Several respondents identified fragmentation between agencies responsible for water, environment, and land-use management as a coordination bottleneck to integrated NBS planning. Different agencies operate under separate mandates, budget lines, and political oversight, with limited mechanisms for joint planning or shared accountability.

Interview participants in all regions expressed frustration with the absence of standardised protocols, design guides, and monitoring frameworks adapted to island conditions. International best practice documents provide valuable reference material but require contextualisation to Macaronesian hydrogeology, climate, vegetation, and institutional arrangements. The lack of locally validated guidance increases project development costs and timelines while elevating perceived risk.

These findings indicate that while conceptual understanding of NBS is maturing, operational capacity remains limited. Structured training programmes, technical guidance materials tailored to Macaronesian conditions, and institutional coordination mechanisms are urgently needed to ensure consistent and competent NBS delivery.

9.1.3 Regulatory and administrative barriers

Stakeholders in all regions highlighted legal and administrative bottlenecks as obstacles to implementation. Many observed that NBS lack formal recognition in existing water and land-use laws, which continue to treat them as ”non-traditional” or pilot activities rather than mainstream water management tools. This regulatory ambiguity creates uncertainty about permitting requirements, approval timelines, environmental impact assessment thresholds, and liability arrangements.

In Madeira and Cape Verde, respondents called for simplified permitting procedures and explicit integration of NBS into water management and spatial planning frameworks. Current processes were described as designed for conventional infrastructure projects, requiring documentation and approvals inappropriate for ecosystem-based interventions. For example, infiltration basins that enhance natural recharge processes may face the

same regulatory scrutiny as industrial wastewater disposal, despite fundamentally different risk profiles.

Water rights and abstraction licensing regimes present additional complexity. Interview participants questioned whether water recharged through managed aquifer recharge becomes "new" water subject to allocation or whether it should be considered recovered resource with claims from downstream users or existing permit holders. This legal ambiguity discourages investment in recharge projects when water rights frameworks fail to provide certainty about future access to recharged volumes.

The slow pace of regulatory adaptation contributes to uncertainty and delays, discouraging both public and private actors from investing in NBS at scale. Regulatory environments remain reactive rather than enabling. Institutionalising NBS within formal governance frameworks through legislative amendment or regulatory guidance would legitimise their use and streamline approval processes, facilitating mainstream adoption while maintaining appropriate environmental safeguards.

9.1.4 Land availability and spatial constraints

Spatial limitations emerged as a recurring concern, especially in Madeira and Cape Verde, where high population density, tourism development, and agricultural competition constrain land availability. Roughly one-third of respondents recognised this as a practical challenge affecting site selection and scaling potential.

Urban areas face particular constraints. Municipalities seeking to implement infiltration basins, constructed wetlands, or bioretention systems must compete with housing, commercial development, transport infrastructure, and public amenities for limited available land. Even where suitable hydrogeological conditions exist, securing adequate space requires difficult political decisions about land-use priorities and potential opportunity costs.

In agricultural zones, farmers expressed concern about dedicating productive land to water management functions, particularly where economic returns are uncertain or accrue to downstream beneficiaries rather than landowners bearing opportunity costs. Compensation mechanisms or payment for ecosystem services schemes were mentioned as potential solutions, but are not yet established in most Macaronesian jurisdictions.

While not a direct barrier to social acceptance, limited space complicates project design and scaling. This reality must be considered in NBS planning to avoid conflicts and identify opportunities for multifunctional designs. Spatial optimisation through integration with existing land uses—such as combining infiltration zones with public parks, agricultural buffer strips, or coastal protection vegetation—can mitigate land constraints while enhancing co-benefits.

9.1.5 Uncertainty over effectiveness and maintenance

While confidence in the environmental benefits of NBS was consistently high, uncertainty about long-term performance and maintenance requirements persisted. Around half of the respondents in Cape Verde and Madeira, and approximately 40% in the Canary Islands and Azores, cited maintenance as a major concern.

Stakeholders expressed a desire for clearer evidence on cost-efficiency, durability, and performance under island-specific conditions, especially under extreme weather events. Questions were raised about clogging of infiltration surfaces, vegetation survival during

droughts, structural integrity during intense rainfall, and recovery capacity after disturbances. The absence of long-term monitoring data from Macaronesian implementations means these concerns cannot be conclusively addressed through local evidence.

Responsibility for ongoing maintenance emerged as a contentious issue. Respondents questioned whether municipal governments, water utilities, landowner associations, or community groups should bear maintenance obligations and associated costs. Unclear institutional responsibilities create implementation hesitancy, as agencies fear being locked into indefinite commitments without adequate budgets or legal mandates.

These findings indicate that demonstration projects with transparent monitoring and comprehensive cost-tracking are essential to build confidence. Data-sharing platforms that document real-world NBS performance in Macaronesian conditions—including challenges and failures alongside successes—could strengthen both institutional and public trust while accelerating learning across the region..

9.1.6 Awareness and communication gaps

Despite broad conceptual support for NBS, many respondents, particularly in Cape Verde and the Azores, acknowledged limited public understanding of how these systems function and what benefits they provide. Only a minority of participants felt that awareness campaigns were reaching the general public effectively beyond environmental specialists and motivated citizens.

Communication challenges operate at multiple levels. Technical language in project proposals and impact assessments remains inaccessible to non-expert audiences. Visual representations of proposed interventions may fail to convey intended functionality, leading to misunderstandings about purpose and expected outcomes. Media coverage, when it occurs, often focuses on project announcements rather than long-term performance, limiting opportunities for public learning.

Educational institutions were identified as underutilised channels for awareness-building. School curricula across Macaronesia rarely address water challenges, NBS principles, or climate adaptation in ways that build environmental literacy and civic engagement from early ages. University programmes produce environmental scientists and engineers, but broader adult education and professional development opportunities remain limited.

Stakeholders emphasised that awareness gaps weaken social ownership and delay behavioural changes necessary for NBS success, such as reducing paved surfaces, protecting infiltration areas, or participating in monitoring. Citizen science initiatives, school-based education on water stewardship, participatory monitoring programmes, and culturally resonant communication that links NBS to heritage and identity can bridge this divide by embedding knowledge into daily life and community values.

9.1.7 Cultural and social resistance

Contrary to expectations based on some international literature (Section 3.4.5), virtually no cultural or social opposition to NBS was observed across Macaronesian regions, with less than 10% of respondents citing this as a concern. However, many participants emphasised that NBS are highly compatible with local traditions of land and water management rather than representing alien impositions.

In Cape Verde and the Azores, traditional ecological knowledge was seen as complementary to modern NBS design. Historical practices such as stone terracing, check dams (locally known as dikes or tranques), rainwater cisterns, and agricultural contouring align conceptually with contemporary infiltration enhancement and erosion control approaches. Several interview respondents suggested that framing NBS as recovery or modernisation of ancestral wisdom could strengthen legitimacy and community ownership.

Religious and cultural festivals celebrating water, agricultural cycles, and landscape stewardship provide opportunities to embed NBS narratives within existing cultural frameworks. Linking projects to patron saints associated with water or rain, traditional water blessing ceremonies, or agricultural heritage can transform technical interventions into culturally meaningful community initiatives.

The absence of social resistance indicates that barriers to NBS uptake are primarily structural, financial, and institutional rather than cultural. This high degree of cultural compatibility provides a strong social foundation for expansion, suggesting that governance frameworks should focus on addressing systemic obstacles rather than attempting to overcome community opposition that largely does not exist.

9.2 Stakeholder perceived opportunities

Manifestation of identified opportunities requires credible demonstration combined with inclusive participation and transparent governance. Demonstrators must be scientifically robust, community-engaged, and practically viable while adapted to local contexts. This means pairing rigorous monitoring with participatory design, communicating openly about costs and maintenance, and tailoring interventions to the resource and spatial realities of each region.

9.2.1 Demonstration and pilot projects

Respondents across all islands emphasised demonstration projects as the highest-priority opportunity for advancing NBS implementation. Visible, well-monitored pilots that generate credible performance data under local conditions were identified as essential for overcoming uncertainty and building institutional confidence.

Stakeholders specified that demonstrations should be designed as learning platforms rather than merely showcases. This requires comprehensive monitoring, capturing hydrological, ecological, economic, and social outcomes; transparent reporting of both successes and challenges; open access to data and lessons learned; and explicit connection to governance frameworks that enable scaling successful approaches.

Site selection for demonstrations should prioritise locations with strong community engagement, supportive municipal leadership, suitable hydrogeological conditions, and ability to address priority water challenges. Strategic distribution across archipelagos ensures that each region develops locally relevant evidence while enabling comparative learning about performance under different climatic and institutional conditions.

9.2.2 Community engagement and co-design

Early and meaningful community involvement emerged as a critical opportunity across stakeholder consultations. Respondents distinguished between tokenistic consultation—where communities are informed of predetermined plans—and genuine co-design, where local knowledge, priorities, and concerns actively shape project development.

Participatory approaches were seen as mechanisms to integrate traditional ecological knowledge with technical expertise, identify locally appropriate sites and designs, build social ownership and stewardship, anticipate and address potential conflicts, and ensure equitable distribution of benefits and responsibilities. Several interview participants noted that projects imposed from above frequently encounter implementation difficulties that participatory processes could have identified and resolved during design phases.

Specific mechanisms suggested include community workshops for site selection and design refinement, citizen science programmes for monitoring and maintenance, school engagement to build intergenerational awareness and pride, partnerships with local NGOs and community associations, and representation on project steering committees with genuine decision-making authority rather than advisory roles.

9.2.3 Public education and awareness

Systematic education and awareness-building represent high-leverage opportunities for creating enabling conditions for NBS expansion. Stakeholders identified multiple channels and approaches spanning formal education systems, public campaigns, experiential learning, professional development, and media engagement.

Integration into school curricula was repeatedly mentioned as essential for building long-term environmental literacy and civic engagement. Age-appropriate content on water cycles, climate adaptation, ecosystem services, and sustainable development can embed NBS concepts within broader environmental education while connecting to local geography and heritage.

Public awareness campaigns should employ diverse communication strategies recognising different learning styles, cultural contexts, and information sources. Traditional media, social media, community events, demonstration site visits, documentary films, and storytelling approaches that connect NBS to cultural identity and shared values were all suggested as valuable components of comprehensive communication strategies.

9.2.4 Institutional collaboration and governance reform

Opportunities for improved institutional coordination and governance reform were identified across all regions. Respondents recognised that fragmented institutional landscapes create inefficiencies, delays, and missed opportunities for integrated approaches, but also acknowledged that achieving meaningful coordination requires deliberate structural and procedural changes.

Specific opportunities include establishing inter-agency coordination committees or NBS task forces with mandates, budgets, and decision-making authority; developing joint permitting procedures that streamline approvals for integrated projects; creating shared monitoring platforms and data management systems accessible across agencies; aligning budget cycles and funding mechanisms to enable multi-agency programmes; and institutionalising regular coordination meetings and joint strategic planning processes.

Several stakeholders noted that EU policy frameworks and funding programmes create incentives for improved coordination, as accessing certain funds requires demonstrated collaboration and integrated approaches. Leveraging these external incentives while building internal institutional culture supportive of cooperation represents a pragmatic pathway for governance evolution.

9.2.5 Financial incentives and policy support

Mobilising adequate financing and aligning policy frameworks emerged as enabling opportunities that could dramatically accelerate NBS implementation. Stakeholders identified multiple financing mechanisms and policy instruments that, if effectively deployed, would address the primary barrier of resource constraints.

EU programmes including the LIFE Programme, Cohesion Fund, European Agricultural Fund for Rural Development, and Horizon Europe research funding provide substantial resources accessible to Macaronesian regions. However, navigating application processes, meeting co-financing requirements, and demonstrating alignment with programme priorities requires capacity and coordination currently limited in some jurisdictions.

National and regional policy instruments, including payment for ecosystem services schemes, water tariff structures that incentivise conservation and recharge, green infrastructure requirements in spatial planning, preferential permitting for NBS, tax incentives or subsidies for landowners implementing infiltration enhancements, and public procurement rules favouring sustainable solutions represent opportunities for creating supportive policy environments.

Incentive-based instruments, if tied to EU Green Deal objectives and national climate adaptation funding, could catalyse private sector participation and accelerate deployment while ensuring alignment with broader sustainability goals.

9.2.6 Leveraging traditional ecological knowledge

In both Cape Verde and the Azores, particularly, respondents stressed the value of ancestral ecological wisdom in guiding contemporary water management and land restoration. Integrating local practical knowledge and traditional approaches with scientific understanding strengthens legitimacy, promotes cultural continuity, and fosters community ownership of NBS initiatives.

Traditional practices such as stone terracing, check dams, rainwater harvesting cisterns, agricultural contouring, and strategic vegetation planting for erosion control embody principles now formalised within NBS frameworks. Documentation, validation, and selective modernisation of these practices—enhanced with contemporary monitoring, materials, and design optimisation while preserving core concepts—can accelerate implementation while honouring heritage.

Engagement with elder knowledge holders, documentation through oral history projects, integration of traditional practices into demonstration sites, and recognition of traditional knowledge in governance processes were all identified as opportunities to bridge ancestral wisdom and contemporary innovation for enhanced outcomes and social legitimacy.

9.3 Synthesis and policy implications

Collective analysis indicates that structural barriers rather than social attitudes represent the main constraints to scaling NBS in Macaronesia. Public acceptance is robust, with over 70% of respondents across all islands viewing NBS as effective, environmentally sound, and appropriate for local conditions. However, financial scarcity, limited institutional capacity, regulatory ambiguity, and technical uncertainties impede practical progress.

These empirical findings from Macaronesia align substantially with the international literature reviewed in Section 3.4, confirming that the region faces challenges documented globally. However, the relative intensity of barriers differs from some international patterns. Notably, social acceptance is stronger in Macaronesia than in some European contexts where NBS face cultural skepticism, while financial and institutional constraints are more acute than in jurisdictions with greater fiscal capacity and established governance frameworks for innovative water management.

To move from acceptance to implementation, three catalysts emerge as essential: demonstrative evidence, transparent governance, and sustained education. Institutional reform must embed NBS within planning and regulatory frameworks, supported by multi-level collaboration across fragmented governance landscapes. Above all, mobilisation of financial and human resources through EU, national, and local channels remains the most critical enabling condition for scaling impact.

In alignment with WP2 objectives, the following strategic directions emerge from stakeholder consultation. Invest in strategically designed pilot and demonstration projects that validate effectiveness, generate learning, and build trust through transparent monitoring and open data sharing. Demonstrations should be distributed across archipelagos to develop locally relevant evidence while enabling comparative learning.

Strengthen technical capacity and institutional cooperation through targeted training programmes for practitioners, development of Macaronesia-adapted technical guidance materials, establishment of inter-agency coordination mechanisms, and creation of communities of practice enabling knowledge exchange across islands.

Mobilise diverse financing sources by aligning NBS initiatives with EU Green Deal priorities, LIFE Programme funding windows, Cohesion Fund instruments, national climate adaptation budgets, and innovative mechanisms including payment for ecosystem services, green bonds, and blended public-private finance.

Enhance communication and education to sustain long-term public engagement and understanding through school curricula integration, public awareness campaigns, citizen science programmes, cultural heritage linkages, and transparent performance reporting from implemented projects.

Embed participatory and co-design processes into every phase of NBS planning, ensuring that local knowledge, traditional practices, citizen priorities, and stakeholder concerns actively shape implementation rather than being accommodated through token consultation.

The governance framework presented in Chapter 10 operationalises these strategic directions through three complementary participatory models designed to address the barriers while leveraging the opportunities identified through Macaronesian stakeholder engagement. Successful implementation requires sustained political commitment, adequate resourcing, and a genuine embrace of collaborative governance principles documented as essential by the communities and institutions that will ultimately

determine whether NBS achieve their potential for enhancing water security and resilience across Macaronesian islands.

10 Water governance framework for social acceptability of NBS

Effective implementation of NBS for water management depends not only on technical design and hydrological suitability but fundamentally on social acceptability and institutional legitimacy. The preceding chapters have documented strong conceptual support for NBS across Macaronesia, yet also identified significant barriers rooted in governance fragmentation, resource constraints, and uncertain accountability arrangements. This chapter addresses these challenges by presenting a comprehensive governance framework designed to enhance social acceptability through inclusive, transparent, and adaptive institutional processes.

The framework comprises three complementary participatory governance models tailored specifically for the Macaronesian context. These models emerge from analysis of stakeholder consultations (Chapter 5), public perception assessments (Chapters 6 and 7), and the barriers and opportunities synthesis (Chapter 9). They address the unique institutional landscape of Macaronesian islands, characterised by institutional fragmentation across multiple agencies, limited technical capacity in some jurisdictions, variable public awareness of NBS principles, constrained financial resources, and the imperative for transparent decision-making to build and maintain trust.

Each model offers distinct mechanisms for stakeholder engagement, co-management, and adaptive governance while sharing core principles of inclusivity, transparency, and ecological sustainability. The models are not mutually exclusive but rather represent different scales and intensities of participatory engagement. Practitioners can select the most appropriate model based on local context, institutional capacity, project scale, and stakeholder readiness. In many cases, elements from multiple models can be combined to create hybrid governance structures tailored to specific site conditions and management objectives.

The governance framework builds directly on empirical findings from the GENESIS stakeholder engagement and public perception studies. Several cross-cutting themes inform the design of all three models.

Trust in scientific and civil society actors, across all islands, scientists and NGOs emerged as the most trusted messengers regarding water and environmental issues. Participatory governance must therefore position these actors as facilitators and mediators between institutions and citizens, reinforcing evidence-based decision-making while bridging technical expertise and local knowledge.

Demand for meaningful participation, successful NBS implementation requires early and substantive involvement of communities in planning, monitoring, and evaluation—not mere consultation after decisions have been made. Workshops, citizen science programmes, and joint planning committees provide avenues for genuine co-design and shared responsibility.

Concerns about financial transparency and long-term viability; stakeholders across regions expressed concerns about the affordability and longevity of NBS, questioning who would bear maintenance costs and whether claimed benefits would materialise. Governance frameworks must therefore include open financial disclosure, clearly defined maintenance responsibilities, and periodic reporting on operational performance to maintain public confidence.

Context-specific implementation needs, participatory mechanisms must reflect local constraints and capacities rather than imposing uniform approaches. In Cape Verde, modular and low-cost approaches are essential given resource limitations; in Madeira, formal governance and financing mechanisms require strengthening; in the Azores and Canaries, public enthusiasm can be channelled through landscape-scale restoration and reforestation initiatives that connect to cultural identity.

Institutional coordination imperative, the fragmented governance landscape, particularly acute in archipelagic systems, requires integration across municipal, island, and regional levels. Establishing inter-institutional committees or NBS task forces can ensure coherence and accountability in decision-making while respecting existing mandates.

Capacity development alongside infrastructure, beyond physical infrastructure, governance must cultivate local competence. Training programmes for municipal staff, technicians, and community groups are essential to ensure that knowledge transfer accompanies every pilot and demonstration site, building sustainable institutional capacity.

Multiple co-benefits for legitimacy, communicating the wider benefits of NBS—biodiversity enhancement, recreation opportunities, landscape aesthetics, employment creation—builds emotional connection and social legitimacy beyond purely hydrological functions. Linking NBS outcomes to local heritage and cultural identity can transform awareness into civic pride and long-term stewardship.

Implementation of the governance models should follow strategic engagement pathways aligned with local readiness and institutional capacity. The process begins with foundational awareness-building and public education, explaining the purpose, risks, and benefits of NBS through schools, local NGOs, and community networks. This initial phase establishes shared understanding and builds the social capital necessary for subsequent collaboration.

As awareness matures, participatory processes become progressively formalised through multi-stakeholder platforms that bring together representatives from government, academia, civil society, and user associations. These platforms provide institutional anchoring for collaborative decision-making, with clear mandates, transparent procedures, and defined accountability structures that ensure inclusivity while maintaining efficiency.

Throughout these processes, particular attention must be given to ensuring that women and underrepresented groups—who often play central roles in household and agricultural water management—are meaningfully included in formal decision-making structures. Gender-responsive participation strengthens not only social equity but also the relevance and sustainability of governance outcomes.

10.1 Design principles for Macaronesian context

The governance models presented here are grounded in principles derived from international best practice in water governance, adapted to address the specific institutional, social, and environmental characteristics of Macaronesian islands. These principles ensure that participatory processes are effective, legitimate, and sustainable over the long term.

Principle 1: Multi-level integration

Effective water governance in Macaronesia requires coordination across the EU, national, regional, and local levels. Given the islands' political status within different national frameworks (Portugal, Spain, and Cape Verde as an independent state), governance structures must reconcile EU directives with national legislation and local customary practices. The models incorporate mechanisms for vertical integration, ensuring that local decision-making aligns with higher-level policy objectives while retaining flexibility to address site-specific challenges.

Principle 2: Institutional coordination

Stakeholder interviews consistently identified institutional fragmentation as a primary barrier to NBS implementation. Water management responsibilities are distributed across multiple agencies including water authorities, environmental departments, agricultural ministries, municipal governments, and geological services. The governance models establish coordination mechanisms, joint decision-making protocols, and clear delineation of responsibilities to overcome this fragmentation while respecting existing institutional mandates.

Principle 3: Inclusive stakeholder engagement

Meaningful participation extends beyond consultation to active involvement in problem definition, solution design, implementation oversight, and adaptive management. The models recognise diverse stakeholder categories including government agencies, water utilities, agricultural producers, tourism operators, environmental NGOs, academic institutions, and local communities. Each group brings distinct knowledge, interests, and capacities that must be effectively integrated into governance processes.

Principle 4: Knowledge integration

Effective NBS governance requires integration of scientific expertise, technical knowledge, local ecological knowledge, and traditional water management practices. Several interview respondents highlighted ancestral water systems such as cisterns, galleries, and traditional terracing as valuable templates for contemporary NBS. The models incorporate mechanisms for systematic knowledge exchange, joint fact-finding, and collaborative learning across different knowledge systems.

Principle 5: Transparency and accountability

Public trust, identified as conditional in several study islands, depends on transparent decision-making processes, accessible information, and clear accountability for outcomes. The models specify information disclosure requirements, participatory monitoring protocols, and accountability mechanisms linking decision-makers to performance metrics and stakeholder feedback.

Principle 6: Adaptive management

Climate variability, evolving scientific understanding, and changing socio-economic conditions require governance structures capable of learning and adjustment. The models

incorporate monitoring systems, regular review cycles, feedback mechanisms, and explicit protocols for modifying management strategies based on new evidence. This adaptive capacity is particularly critical for novel NBS approaches where long-term performance data may be limited.

Principle 7: Resource mobilisation and sustainability

Financial constraints emerged as a significant barrier across all study sites. The models address financing through diversified revenue streams including user fees, environmental service payments, EU structural funds, national grants, and innovative financing mechanisms. Governance structures include financial planning components, cost-sharing arrangements, and strategies for long-term operational sustainability beyond initial project funding.

Principle 8: Cultural legitimacy

Stakeholder interviews emphasised the importance of culturally appropriate engagement methods and alignment with local values. Governance processes must accommodate linguistic diversity (Portuguese, Spanish, and Creole), respect traditional authority structures, recognise historical water rights and practices, and frame NBS within culturally resonant narratives of stewardship, resilience, and community well-being.

10.2 Model 1: Community-based co-management

10.2.1 Model overview and applicability

The Community-Based Co-Management model establishes formal partnerships between government authorities and local communities for managing specific NBS interventions. This model is most appropriate for:

- Small to medium-scale NBS projects (local infiltration basins, reforestation watersheds, traditional gallery systems),
- Rural or peri-urban areas with cohesive community structures and social capital,
- Contexts where local communities have direct livelihood dependence on water Resources,
- Sites with existing traditional water management practices or organisations,
- Situations requiring intensive local stewardship and maintenance.

This model emerged from stakeholder consultations particularly in Cape Verde, Faial, and El Hierro, where respondents emphasised the importance of community ownership, local knowledge integration, and grassroots engagement. It builds on successful precedents in participatory reforestation, contour bunding, and cooperative water management documented in the region.

10.2.2 Governance structure

Local Water Management Committee, the core institutional innovation is the Local Water Management Committee (LWMC), a formal body with representation from:

- Community representatives (elected by local assemblies or traditional mechanisms).
- Municipal or regional water authority representatives.
- Agricultural extension services or farmers' associations.
- Technical advisors (hydrogeologists, ecologists, engineers).
- Environmental organisations or watchdog groups.

Committee composition should aim for gender balance and representation of diverse water user groups including agriculture, domestic supply, small enterprises, and environmental interests. Membership terms are typically 3 years with staggered rotation to ensure continuity of institutional knowledge.

Roles and Responsibilities, the LWMC is responsible for:

- Participatory planning, developing annual work plans for NBS operation and maintenance in consultation with the broader Community.
- Resource allocation, making decisions on allocation of committee-managed funds, including user fee revenue and municipal transfers.
- Operational oversight, supervising routine maintenance activities, monitoring NBS performance, and coordinating with technical service providers.
- Conflict mediation, resolving local disputes over water access, land use near NBS infrastructure, or benefit distribution.
- Communication, serving as liaison between community members and government agencies, translating technical information for local audiences.
- Compliance monitoring, ensuring that NBS operations comply with environmental permits, water quality standards, and safety regulations.

Government authorities retain ultimate legal responsibility for permit compliance, water quality protection, and public safety, but delegate day-to-day operational management to the LWMC under formal co-management agreements.

10.2.3 Decision-making processes

The model employs a graduated decision-making protocol:

- Routine operational decisions (maintenance scheduling, minor repairs, information dissemination) are made by LWMC through simple majority voting at monthly meetings.
- Significant operational decisions (budget allocation, hiring service providers, modifying operational protocols) require LWMC supermajority (two-thirds) approval plus consultation with broader community through open forums.
- Strategic decisions (major infrastructure modifications, new NBS implementation, changing financing mechanisms) require LWMC consensus, community referendum or assembly approval, and formal agreement by government water authority.

All LWMC meetings are open to community observation, with minutes publicly posted within one week. Decisions affecting specific user groups or property owners require prior notification and opportunity for comment.

10.2.4 Implementation mechanisms

Table 10.1 provides a list of implementation mechanisms.

Table 10.1: Mechanism

Mechanism	Description
Co-Management Agreement	Formal legal document signed by municipal/regional water authority and LWMC defining respective rights, responsibilities, liability arrangements, duration, and amendment procedures. Typically 5-10 year term with renewal provisions.
Community Water Fund	Dedicated financial account controlled by LWMC, capitalised through modest user fees, municipal transfers, and revenue from ecosystem services. Covers routine maintenance, minor capital
Voluntary Stewardship Corps	Organised community volunteer programme for routine monitoring, basic maintenance (vegetation management, debris removal, simple repairs), and educational outreach. Provides mechanism for community members to contribute labor in lieu of or reduction of water fees
Technical Support Services	Regional water authority or geological service provides advisory support including quarterly site visits, water quality testing, hydrogeological monitoring, troubleshooting, and technical training for LWMC.
Capacity Building Programme	Structured training for LWMC members and community volunteers covering NBS principles, basic hydrogeology, maintenance techniques, financial management, meeting facilitation, conflict resolution, and regulatory compliance. Initial intensive training followed by annual refresher workshops.
Monitoring Protocol	Community-based monitoring system with simple indicators (infiltration rates, vegetation health, visual inspections) collected monthly by volunteers, supplemented by technical monitoring (groundwater levels, water quality) conducted quarterly by professionals. Data shared transparently via

10.2.5 Financing and resource allocation

The model employs diversified financing combining:

- User fees, modest volumetric charges or flat fees for households and enterprises benefiting from improved water availability, collected by the municipality and transferred to the Community Water Fund.
- Municipal operating grant, annual transfer from local government based on performance metrics (maintenance compliance, monitoring data quality, stakeholder participation rates).
- Payment for ecosystem services, revenue from downstream water users, tourism sector, or conservation programmes benefiting from watershed protection and aquifer recharge.
- Project grants, competitive access to regional, national, or EU funding for infrastructure upgrades, capacity building, or innovation pilots.
- In-kind contributions**,** volunteer labor, donated materials, and pro bono professional services.

Financial management follows transparent protocols with quarterly reporting to community, annual external audit, and compliance with public procurement regulations for expenditures exceeding defined thresholds.

10.2.6 Accountability and performance monitoring

Accountability operates through multiple channels:

- Downward accountability to the community through open meetings, public financial reports, community satisfaction surveys, and LWMC recall provisions.
- Upward accountability to the water authority through annual performance reports, compliance audits, and adherence to the co-management agreement terms.
- Horizontal accountability to peer LWMCs through regional network meetings, performance benchmarking, and peer learning exchanges.

Performance is assessed against indicators including technical metrics (NBS functionality, water quality maintenance), financial metrics (cost recovery rates, budget execution), governance metrics (meeting frequency, decision transparency, complaint resolution), and social metrics (participation rates, stakeholder satisfaction, equity in benefit distribution).

10.3 Model 2: Multi-stakeholder platform

10.3.1 Model overview and applicability

The Multi-Stakeholder Platform (MSP) model establishes formalised coordination mechanisms bringing together diverse institutional actors, sectoral representatives, and civil society organisations to guide water resource management and NBS implementation at watershed, island, or regional scales. This model is most appropriate for:

- Large-scale or multi-site NBS programmes requiring coordination across administrative jurisdictions.
- Contexts with multiple, potentially competing water uses (agriculture, tourism, urban supply, ecosystem conservation).
- Situations requiring integration of diverse technical expertise and knowledge systems.
- Settings where institutional fragmentation creates coordination challenges.
- Strategic planning and policy development processes for water sector.

This model addresses the institutional coordination gaps identified across all study islands, particularly in Gran Canaria and Madeira where multiple agencies and complex governance arrangements characterise the water sector. It builds on emerging MSP practices in European water management and collaborative governance frameworks internationally.

10.3.2 Governance structure

Platform Composition, the MSP comprises three tiers of engagement:

- Steering Committee, 12-18 members representing core institutional actors including regional water authority, environmental ministry or department, municipal associations, major water utilities, agricultural federation, tourism association, environmental NGO coalition, academic consortium, and geological service. Makes strategic decisions and approves the platform work programme.
- Technical Working Groups, thematic groups (typically 3-5) focused on specific issues such as aquifer recharge techniques, water quality monitoring, financing mechanisms, stakeholder engagement, and climate adaptation. Each group includes 8-15 technical experts, practitioners, and relevant stakeholder representatives.
- Broader Stakeholder Assembly, open forum convened semi-annually for information sharing, input on strategic directions, and accountability. Any interested party can participate, including individual farmers, community groups, small businesses, citizens' organisations.

Membership selection balances institutional representation, technical expertise, gender and generational diversity, and inclusion of marginalised groups. Steering Committee members serve staggered 3-year terms with possibility of reappointment. The platform is chaired by a neutral facilitator selected by consensus, typically a senior public servant, academic, or respected civil society leader.

Institutional Anchoring, while the MSP functions as a collaborative network, it requires formal institutional anchoring to ensure legitimacy, access to resources, and legal standing. Typical arrangements include:

- Establishment through a regional decree or ordinance recognizing the platform as official advisory body to water authority,
- Secretariat function hosted by water authority, regional development agency, or university, providing administrative support, meeting coordination, and documentation,
- Formal consultation requirements mandating government agencies to present major water policy proposals to MSP for comment before finalisation,

- Budget allocation for platform operations including secretariat costs, meeting expenses, technical studies, and capacity building.

10.3.3 Decision-making processes

The MSP operates primarily through consensus-building rather than formal voting. Decision processes include:

- Consensus protocol, steering Committee aims for consensus through iterative deliberation. If consensus cannot be reached after reasonable effort, decisions can be made by 75% supermajority with minority views recorded and published.
- Technical advice process, working groups develop technical recommendations through expert deliberation, literature review, stakeholder consultation, and pilot testing. Recommendations are presented to Steering Committee with explicit documentation of scientific evidence, stakeholder input, implementation feasibility, and dissenting perspectives.
- Joint fact-finding, when stakeholders disagree on factual matters (e.g., aquifer capacity, water quality trends, cost-benefit analysis), the platform commissions independent technical assessments with stakeholder involvement in defining study scope and reviewing findings.
- Policy negotiation, for contentious issues involving tradeoffs between stakeholder interests, the platform facilitates structured negotiation processes including interest-based bargaining, scenario analysis, and development of package deals addressing multiple stakeholder concerns.

All platform deliberations are documented transparently with meeting summaries, background papers, and decision rationales published on accessible web portal. Stakeholder Assembly provides opportunity for broader input and accountability.

10.3.4 Implementation mechanisms

Mechanism	Description
Strategic Planning Process	MSP develops multi-year strategic plans for NBS deployment and water resource management. Process includes situation analysis, stakeholder visioning workshops, scenario development, target setting, action planning, and monitoring framework design. Plans inform government policy and guide funding allocation.
Coordination Protocols	Formal agreements among member agencies defining information sharing procedures, joint permitting processes, coordinated field operations, shared monitoring systems, and mutual support arrangements. Reduces duplication and institutional conflict.

Mechanism	Description
Knowledge Management System	Integrated information platform consolidating hydrogeological data, monitoring results, research findings, regulatory documents, and practical guidance. Accessible to all stakeholders with appropriate data quality control and privacy safeguards. Enables evidence-based decision-making and adaptive management.
Pilot Project Programme	Competitive funding programme for demonstration projects testing innovative NBS approaches, governance arrangements, or financing mechanisms. Projects selected through transparent process by Technical Working Groups, implemented by diverse actors, rigorously monitored, and results disseminated widely to inform scaling decisions.
Capacity Development Initiative	Systematic programme to build technical, institutional, and social capacities required for NBS governance. Includes professional training courses, study tours, twinning arrangements with experienced jurisdictions, development of guidance documents and toolkits, mentoring programmes, and communities of practice.
Communication Strategy	Coordinated approach to public communication about water challenges, NBS solutions, and governance processes. Employs diverse channels (traditional media, social media, community events, educational programmes) and culturally appropriate messaging. Builds public awareness, manages expectations, and strengthens social legitimacy of NBS investments.
Conflict Resolution Mechanism	Structured processes for addressing disputes among stakeholders including mediation services, independent expert panels, and grievance procedures. Provides alternatives to litigation and maintains constructive relationships during disagreements. Critical for sustained collaboration in contexts with competing interests.

10.3.5 Role of science and technical expertise

The MSP model explicitly integrates scientific and technical expertise into governance through:

- Scientific Advisory Panel, standing group of 5-8 distinguished researchers from hydrogeology, ecology, engineering, social sciences, and economics providing

independent advice to Steering Committee on scientific dimensions of policy choices.

- Commissioned studies, targeted research on priority questions commissioned from universities, research institutes, or consultancies, with scoping and oversight by Technical Working Groups.
- Evidence synthesis, systematic reviews of scientific literature, international best practice, and local empirical evidence to inform policy development and project design.
- **Monitoring and evaluation**, rigorous performance assessment of NBS interventions using scientific protocols, statistical analysis, and peer review to generate credible evidence for adaptive management.

Importantly, the model also recognises and systematically integrates practical knowledge from water managers, farmers' experiential understanding, and traditional ecological knowledge through dedicated engagement mechanisms within Technical Working Groups.

10.3.6 Financing and sustainability

Platform operations require sustained financing. Typical models include:

- Core budget, annual allocation from regional government covering secretariat operations, meeting costs, and basic technical support (typically 150,000-300,000 EUR depending on scale).
- Member contributions, in-kind support from member organisations including staff time, meeting facilities, data provision, and technical expertise.
- Project funding, competitive grants from EU, national, or international sources for specific initiatives, studies, or capacity building programmes.
- Water sector levy, small charge on water abstraction permits or utility revenues, dedicated to collaborative governance and innovation funding.

Long-term sustainability depends on demonstrating value to member organisations and government funders through tangible improvements in coordination, more efficient resource use, enhanced policy quality, and measurable NBS performance gains.

10.4 Model 3: Adaptive collaborative governance

10.4.1 Model overview and applicability

The Adaptive Collaborative Governance (ACG) model establishes flexible, learning-oriented governance arrangements particularly suited for contexts characterised by high uncertainty, complex ecological dynamics, and evolving stakeholder constellations. This model is most appropriate for:

- Novel NBS interventions with limited local precedent or performance data,
- Climate adaptation initiatives addressing future scenarios with substantial uncertainty
- Situations requiring integration of rapidly evolving scientific knowledge and technologies,

- Dynamic contexts where stakeholder interests, institutional arrangements, or resource conditions may shift significantly,
- Programmes explicitly designed as learning laboratories for innovation and knowledge generation.

This model addresses the technical uncertainty and institutional fluidity highlighted in stakeholder consultations, particularly concerns about long-term performance of unfamiliar NBS approaches and the need for flexible governance capable of responding to climate change impacts and socio-economic transitions. It synthesises international experience with adaptive management, collaborative governance, and social-ecological resilience.

10.4.2 Core principles

The ACG model is built on several foundational principles:

- Explicit uncertainty, rather than seeking definitive solutions, ACG embraces uncertainty as inherent in complex social-ecological systems. Management strategies are framed as hypotheses to be tested, refined, and potentially revised based on monitoring results.
- Structured learning, systematic processes for generating, sharing, and applying knowledge gained through implementation experience. Learning loops connect monitoring data to management adjustments and strategic refinement.
- Collaborative experimentation, stakeholders jointly design and conduct management experiments, share interpretation of results, and negotiate appropriate responses. This distributes risk and builds shared ownership of adaptive decisions.
- Flexible institutions, governance structures and processes designed for modification as context changes or understanding deepens. Rules include explicit review triggers and amendment procedures.
- Resilience focus, management aims to enhance system resilience through diversity, modularity, and adaptive capacity rather than optimizing for specific performance targets that may become obsolete.

10.4.3 Governance architecture

ACG employs nested, polycentric structures operating at multiple scales:

- Site-Level Action Learning Groups, small teams (8-12 members) of managers, technical specialists, and key stakeholders directly involved in operating specific NBS sites. Meet quarterly to review monitoring data, assess performance against objectives, identify surprises or anomalies, diagnose causes, design management adjustments, and document lessons learned.
- Island-Level Coordination Council, brings together representatives from multiple Action Learning Groups plus water authority staff, researchers, and strategic stakeholders. Meets semi-annually to synthesise insights across sites, coordinate management strategies, align with policy frameworks, allocate adaptive management resources, and facilitate knowledge exchange.

- Regional Learning Network, Macaronesia-wide network connecting Coordination Councils from different islands. Convenes annually (in-person) plus quarterly virtual exchanges to share experiences across archipelagos, commission comparative studies, develop common protocols and standards, and build regional capacity for adaptive NBS governance.

This nested structure enables local responsiveness while building system-wide learning capacity. Formal linkages ensure vertical information flow and horizontal knowledge sharing while respecting local autonomy in management decisions.

10.4.4 Adaptive management cycle

The model operationalises adaptation through structured management cycles:

- Assessment Phase, define management objectives, characterise baseline conditions, identify key uncertainties, map stakeholder perspectives, and establish monitoring systems. Typically conducted at project initiation or major review points.
- Design Phase, develop alternative management strategies, predict likely outcomes under different scenarios, evaluate tradeoffs, select an initial approach through stakeholder deliberation, and design monitoring to test critical hypotheses. Incorporates participatory modelling and scenario analysis.
- Implementation Phase, execute selected management strategy while maintaining detailed records of actions, context, and decisions. Duration varies by management cycle (typically 1-3 years for NBS) with potential for interim adjustments if critical thresholds are crossed.
- Monitoring Phase, systematic collection of ecological (groundwater levels, water quality, vegetation health), technical (infiltration rates, infrastructure integrity), social (stakeholder perceptions, participation rates), and financial (costs, revenues) data according to the monitoring plan. Employs both professional and participatory methods.
- Evaluation Phase, collaborative assessment of outcomes against objectives, comparison with predictions, identification of surprises, diagnosis of causal mechanisms, and deliberation on implications for management and understanding. Facilitated workshops synthesise diverse evidence and perspectives.
- Adjustment Phase, based on evaluation findings, stakeholders negotiate modifications to management strategies, monitoring protocols, governance arrangements, or fundamental objectives. Changes are documented with explicit rationale to support organizational learning.

The cycle repeats with each iteration building understanding and refining management approaches. Critical to success is maintaining stakeholder engagement throughout the cycle and ensuring that monitoring data actually inform decision-making rather than being collected but not used.

10.4.5 Knowledge systems and learning infrastructure

ACG requires robust systems for capturing, organising, and mobilising knowledge (Table 10.2).

Table 10.2: Mobilising Knowledge

Component	Description
Monitoring Database	Integrated system housing hydrogeological data, ecological indicators, operational records, cost data, and stakeholder feedback. Open access with appropriate safeguards. Supports visualization, statistical analysis, and automated alerts for threshold exceedances.
Learning History Archives	Repository of meeting records, evaluation reports, decision rationales, design documents, and case narratives documenting evolution of management approaches and governance arrangements. Preserves institutional memory and enables retrospective analysis.
Comparative Case Library	Structured database of NBS experiences from other jurisdictions including project designs, performance data, governance arrangements, lessons learned, and contact information. Enables benchmarking and adaptation of proven approaches.
Modeling and Scenario Tools	User-friendly simulation models for exploring consequences of management alternatives, testing sensitivity to uncertainties, and evaluating future scenarios. Supports participatory modeling workshops where stakeholders develop shared understanding of system dynamics.
Communities of Practice	Networks of practitioners working on similar challenges across sites and islands. Facilitate peer learning through site visits, webinars, collaborative problem-solving, and joint development of protocols and tools. Build relationships supporting informal knowledge exchange.
Synthesis and Communication	Periodic synthesis reports distilling lessons learned across adaptive management experiments, translating technical findings for policy and practitioner audiences, and communicating successes and challenges to build public understanding and maintain political support.

10.4.6 Managing adaptive governance challenges

ACG faces characteristic challenges requiring explicit attention:

- Maintaining commitment, adaptive processes require sustained engagement over years or decades, but political cycles, staff turnover, and stakeholder fatigue can undermine continuity. Strategies include institutionalizing review cycles, building organizational routines, cultivating diverse champions across institutions, and celebrating learning achievements to maintain motivation.
- Balancing stability and flexibility, while adaptation requires flexibility, stakeholders also need predictability for planning and investment. The model addresses this through tiered decision rules, distinguishing routine adjustments (delegated to managers) from strategic shifts (requiring broader deliberation), and establishing presumptive management approaches that continue unless monitoring triggers reconsideration.
- Avoiding paralysis by analysis, rigorous learning processes can become so elaborate that they impede timely action. Guard against this through clear decision protocols, reasonable time bounds for deliberation, acceptance of imperfect information, and bias toward action with monitoring rather than indefinite study.
- Ensuring equitable learning, technical complexity can marginalise less scientifically literate stakeholders in learning processes. Address through accessible information formats, capacity building, deliberate facilitation ensuring diverse voices are heard, and valuing multiple knowledge systems including local and traditional ecological knowledge.
- Resource constraints, comprehensive monitoring and evaluation require sustained funding. Prioritise indicators most critical for key management questions, employ cost-effective participatory monitoring where appropriate, leverage research partnerships, and build monitoring costs into initial project design and financing plans.

10.5 Model selection and application guidance

10.5.1 Comparative Model Assessment

The three governance models represent different approaches with distinct strengths, requirements, and optimal applications. Selection should be based on careful assessment of context provided in Table 10.3.

Table 10.3: Governance Models

Criterion	Community Co-Management	Multi-Stakeholder Platform	Adaptive Collaborative
Optimal Scale	Local (single site/community)	Island/regional (multiple sites)	Variable (nested multi-scale)

Criterion	Community Co-Management	Multi-Stakeholder Platform	Adaptive Collaborative
Primary Function	Operational management & local stewardship	Coordination, policy development, strategic planning	Learning, experimentation, managing uncertainty
Key Strength	Deep local engagement, ownership, accountability	Cross-sector coordination, technical expertise, policy influence	Flexibility, knowledge generation, resilience
Main Limitation	Limited technical capacity, narrow jurisdiction, potential insularity	Complexity, slow deliberation, may lack grassroots connection	Demanding of resources and commitment, can defer difficult decisions
Institutional Requirements	Moderate - co-management agreement, technical backstopping	High - formal recognition, dedicated secretariat, budget allocation	High - sustained funding, research partnerships, cultural change
Best Context	Cohesive communities, manageable scale, direct livelihood links	Fragmented institutions, competing uses, need for coordination	High uncertainty, novel approaches, commitment to learning

10.5.2 Decision framework for model selection

To select the most appropriate governance model(s) for a specific context, practitioners should systematically assess the following factors.

Step 1: Characterise Project Scale and Complexity

- Small, site-specific interventions favor Community Co-Management,
- Multi-site programmes or watershed-scale initiatives suggest Multi-Stakeholder Platform,
- Complex interactions across scales may warrant nested combination of models.

Step 2: Assess Institutional Landscape

- Cohesive local community structures enable Community Co-Management,
- Fragmented agencies with coordination gaps call for Multi-Stakeholder Platform,

- Capacity for learning-oriented institutions favors Adaptive Collaborative Governance.
-

Step 3: Evaluate Stakeholder Readiness

- High social capital and trust support Community Co-Management,
- Diverse, organised stakeholder groups suit Multi-Stakeholder Platform,
- Willingness to experiment and tolerate uncertainty enables Adaptive Collaborative Governance.

Step 4: Consider Knowledge and Uncertainty

- Proven technologies with predictable performance suit Community Co-Management or Multi-Stakeholder Platform,
- Novel NBS approaches or high ecological uncertainty indicate Adaptive Collaborative Governance,
- Need for knowledge integration across sectors suggests Multi-Stakeholder Platform.

Step 5: Assess Resources and Capacity

- Limited financial and technical resources may constrain sophisticated models,
- Strong research partnerships enable Adaptive Collaborative Governance,
- Adequate sustained funding required for Multi-Stakeholder Platform infrastructure.

10.5.3 Hybrid and combined approaches

In practice, elements from multiple models can be productively combined to address complex governance challenges. Common hybrid configurations include:

- Community Co-Management within Multi-Stakeholder Platform.,local Water Management Committees operate individual sites while participating in island-level MSP for coordination and policy input. Combines local ownership with strategic coherence.
- Adaptive Collaborative Governance using MSP structure, Multi-Stakeholder Platform adopts adaptive management principles and structured learning processes. Leverages MSP coordination capacity while building flexibility and learning orientation.
- Phased governance evolution, begin with Community Co-Management for pilot projects, transition to Multi-Stakeholder Platform as programme scales, incorporate Adaptive Collaborative Governance elements as experience accumulates and capacity develops.

The key is ensuring clarity about which model applies at which scale, how different governance bodies relate to each other, and where decision authority resides for different types of choices. Documented governance frameworks, memoranda of understanding, and clear communication prevent confusion and jurisdictional conflicts.

10.5.4 Implementation pathway

Establishing participatory governance structures requires thoughtful sequencing:

1. Stakeholder analysis and mapping to identify relevant actors, assess interests and capacities, and understand existing relationships and power Dynamics,
2. Governance design process involving key stakeholders in selecting and tailoring governance model(s), defining roles and responsibilities, and establishing decision rules and procedures,
3. Formalisation through appropriate legal instruments (co-management agreements, platform charters, regional ordinances) conferring legitimacy and defining relationships with existing institutions,
4. Capacity building providing training, technical support, and facilitation to enable effective participation and build confidence in collaborative processes,
5. Pilot phase with manageable scope allowing governance structures to develop working relationships, test procedures, and build trust before tackling more challenging decisions,
6. Iterative refinement through regular review and adjustment of governance arrangements based on experience, addressing problems proactively, and celebrating successes to maintain momentum.

Timeline for full implementation typically spans 2-4 years from initiation to fully functional governance system. Early wins and visible progress are important for maintaining stakeholder engagement and political support during this establishment period.

11 Conclusions and recommendations

This deliverable presents a comprehensive analysis of social acceptability and participatory governance frameworks for nature-based solutions in Macaronesian water management, fulfilling GENESIS Work Package 2 Task 2.1 objectives. Drawing on extensive stakeholder engagement, public perception assessment, regulatory analysis, and international best practice review, the work establishes evidence-based foundations for implementing NBS as credible, socially legitimate, and institutionally viable approaches to water security and climate adaptation across the Azores, Canary Islands, Madeira, and Cape Verde.

11.1 Main findings

Strong social acceptability foundation. Over 70% of stakeholders across all regions view NBS as environmentally sound, technically appropriate, and culturally compatible with local values. This robust support transcends institutional boundaries, with government officials, technical professionals, agricultural producers, and citizens expressing similar endorsement levels. Traditional practices including rainwater harvesting, terracing, and check dams align conceptually with contemporary NBS frameworks, enabling interventions to be framed as enhancement of ancestral ecological wisdom rather than alien impositions.

Barriers are structural, not social. Implementation obstacles are overwhelmingly structural and institutional rather than rooted in social opposition. Financial constraints (identified by 52-70% of respondents depending on region), limited technical capacity, institutional fragmentation, regulatory ambiguity, and performance uncertainty represent primary barriers. Cultural resistance or aesthetic objections were rarely cited. The absence of dedicated financing mechanisms, combined with public budgets favouring conventional infrastructure, creates systematic impediments even where political will exists.

Differentiated regional contexts require tailored approaches. While commonalities enable knowledge transfer, critical differences in economic capacity, institutional maturity, and dominant water challenges necessitate context-specific adaptation. The Azores exhibit strong social capital favouring community-based co-management; the Canary Islands possess technical capacity but face institutional fragmentation requiring multi-stakeholder platforms; Madeira needs strengthened municipal capacity; Cape Verde demands modular, low-cost approaches with adaptive learning.

Governance is central to social acceptability. Social legitimacy depends fundamentally on governance quality—inclusivity, transparency, accountability, and responsiveness. Scientists and NGOs emerged as most trusted actors, suggesting governance processes positioning them as facilitators can leverage credibility whilst mitigating distrust of government-led initiatives. The three governance models—Community-Based Co-Management, Multi-Stakeholder Platforms, and Adaptive Collaborative Governance—operationalise these principles through distinct mechanisms appropriate for different scales and contexts.

11.2 Key recommendations

Institutional and regulatory. Formalise NBS within legal frameworks through amended water legislation and spatial planning regulations with clear permitting pathways. Establish

inter-agency coordination mechanisms across municipal, island, regional, and national levels. Integrate NBS systematically into river basin management plans and climate adaptation strategies. Clarify water rights for managed aquifer recharge to provide investment certainty.

Financial and economic. Develop dedicated NBS financing mechanisms capitalised through environmental levies or budget allocations aligned with climate priorities. Coordinate regional applications to EU programmes (LIFE, Cohesion Fund, Horizon Europe) leveraging collaborative proposals. Implement payment for ecosystem services schemes compensating landowners for water infiltration and recharge services. Establish economic valuation standards capturing co-benefits including biodiversity, recreation, and climate resilience.

Capacity development. Create Macaronesia NBS training programme delivering technical training for practitioners, governance skills for community representatives, and facilitation training for coordinators.

Demonstration and learning. Implement strategic demonstration portfolio distributed across archipelagos generating credible local evidence. Design pilots explicitly as governance experiments testing participatory approaches alongside hydrological performance. Establish regional data sharing platform consolidating monitoring data, cost tracking, and lessons learned. Document and disseminate both successes and challenges transparently.

Communication and engagement. Frame NBS through heritage connections and traditional ecological knowledge rather than purely technical arguments. Integrate NBS into school curricula building long-term environmental literacy. Position scientists and NGOs as primary communicators capitalising on their credibility. Establish citizen science programmes enabling community participation in monitoring.

Governance implementation. Apply the Chapter 10 decision framework to match governance models strategically to local context and project characteristics. Embrace hybrid approaches combining elements from multiple models and phased evolution as capacity develops. Ensure meaningful participation through genuine co-design rather than token consultation. Commit authentically to transparency, inclusivity, accountability, and responsiveness principles. Invest in capacity building, facilitation, and relationship building as foundational enablers. Maintain patience with collaborative processes whilst pursuing tangible outcomes. Institutionalise adaptive learning through regular review cycles and explicit adjustment protocols.

Participatory water governance represents a fundamental transformation in how water resources and NBS interventions are conceived, designed, implemented, and managed. When implemented authentically, it builds social capital, enhances institutional capacity, improves decision quality, and increases likelihood that NBS investments deliver sustained benefits for communities and ecosystems.

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