NbS4AfrRes

Nature-based Solutions for African Resilience

Updated needs analysis and implementation plan

Project number: 101128758

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Executive Summary

This report presents the findings from a comprehensive needs analysis conducted for the NbS4AfrRes project, an ERASMUS+ funded initiative focused on capacity building and curriculum development in Nature-based Solutions (NbS) across four African Higher Education Institutions (HEIs) in Senegal and South Africa, in collaboration with European partners. The study aimed to identify gaps, challenges, and needs in integrating NbS into educational programs to enhance climate resilience and sustainable development.

The analysis employed both quantitative and qualitative methods, including online surveys and in-depth interviews with stakeholders such as students, academic staff, environmental professionals, engineers, government officials, and decision-makers. The data collected (over 250 surveys and interview participants) provided insights into the current state of NbS education and identified specific improvement needs.

The findings reveal a strong demand for NbS-related education, particularly among students, academic staff, and professionals in both countries. Senegal showed a lower awareness of NbS and a more significant need for foundational NbS education, especially among students and academic staff. While exhibiting higher overall familiarity levels of NbS concepts and previous involvement with NbS-related projects among professionals, South Africa revealed a critical need to bolster NbS understanding among students and government officials. There is strong support for incorporating NbS into undergraduate and postgraduate curricula, with an emphasis on practical applications and case studies. Additionally, there is overwhelming support for integrating indigenous knowledge into NbS training.

The study identified several key gaps and challenges in both South African and Senegalese HEIs:

- Inadequate incorporation of sustainable practices and NbS content in current curricula, along with insufficient integration of climate change;
- Significant need for multidisciplinary skills, technical skills in wetland soils and hydrology, and greater environmental awareness among graduates;
- Limited tools and resources for ecosystem evaluation and data analysis;
- Practical application of knowledge is often lacking, with gaps in hands-on projects and research-based solutions; and
- Deficiencies in project design and planning, as well as challenges in stakeholder engagement and participatory modeling.

To address these issues, the project has committed to updating six core courses, and a set of degrees that could potentially be updated with these selected EU courses at the four African

HEIs. Additionally, a newly proposed one-year Master degree on NbS for environmental science and engineering will be developed at UCAD during the project, and a new Master hosted by the Institute for Water Research (Rhodes University) is in the discussion phase to be finalized and implemented after the current project. The six courses being updated with African case studies and real-life assignments include (European partner that originally developed the course):

1. Engineering: Building with Nature (TU Delft);
2. Beyond Engineering: Building with Nature (TU Delft);
3. Responsible Innovation: Ethics, Safety and Technology (TU Delft);
4. Joint Water Management and Planning in our Social-Ecological Systems (AgroParisTech/INRAE);
5. Multidisciplinary Research Methods for Engineers (TU Delft); and
6. Co-Creating Sustainable Cities (TU Delft)

The project has established several committees to oversee implementation, including Local Project Management Committees (LPMC), a Project Management-Curriculum Development Committee (PM-CDC), a Core Committee of lead researchers from the four African HEIs, and an Advisory Committee with external partners from HEIs and decision-makers in South Africa and Senegal.

Overall, the project is an opportunity to integrate NbS into environmental sciences and civil engineering curricula, fostering climate resilience, multidisciplinary skills, co-creation, ethical considerations, and practical training for students and professionals. This will contribute to creating sustainable and resilient environments in Senegal and South Africa, aligning with international agendas such as the Sustainable Development Goals (SDGs) and Africa Agenda 2063.

The following sections summarise the feedback obtained from professionals and key decision-makers for the two project countries. These support the need for our project's focal courses and skills. Additionally, this feedback provides insight into other skills that are in demand for professionals.

Summary of survey interviews with professionals and key decision makers – South Africa

Twenty-four participants were interviewed in South Africa to gather in-depth feedback on the questions that were covered in the survey, with particular focus on gaps and challenges. Thirty-three key respondents who work in South Africa, completed the survey. Thus, a total of fifty-seven key respondents are included in this report on gaps and challenges in NbS related education and training. These respondents include:

1) **Key participants and Decision-makers in South African HEIs**:
   - One Deputy Vice Chancellor of Research
   - Two HEI Institutional Directors (Institutional Planning Unit, Environmental Sustainability)
   - Two Deans (in faculties of Science and Education)
   - Eighteen academic staff in various departments
   - Heads / Directors of various departments (Higher Education, Chemistry, Architecture, Civil Engineering, Environmental Science)
   - Two administrators

2) **Decision-makers at national level:**
   - Four representatives of Department of Forestry, Fisheries and the Environment
   - One representative of Department of Higher Education and Training
   - One representative of Provincial Government Department of Environmental Affairs and Development Planning
   - One representative of Department of Water and Sanitation
   - Three Research Managers at the Water Research Commission (a national funding agency)

3) **Professionals at consulting firms:**
   - Two Executive Director / Director
   - One Senior GIS specialist
   - Thirteen Professionals in the build environment or environmental science field
   - One representative of a Professional accreditation body

Summary of priorities identified by survey respondents

The survey asked which *skills should be prioritized in relation to NbS-focused education and training in the country(-ies) where you are working to address complex environmental challenges?* The respondents were provided a checklist from which they could choose more than one response and add items that were missing in the checklist. The figure below shows the skills

selected by the 33 key respondents who work in South Africa. Note the strong support for multidisciplinary methods, design options for NbS, and stakeholder engagement,

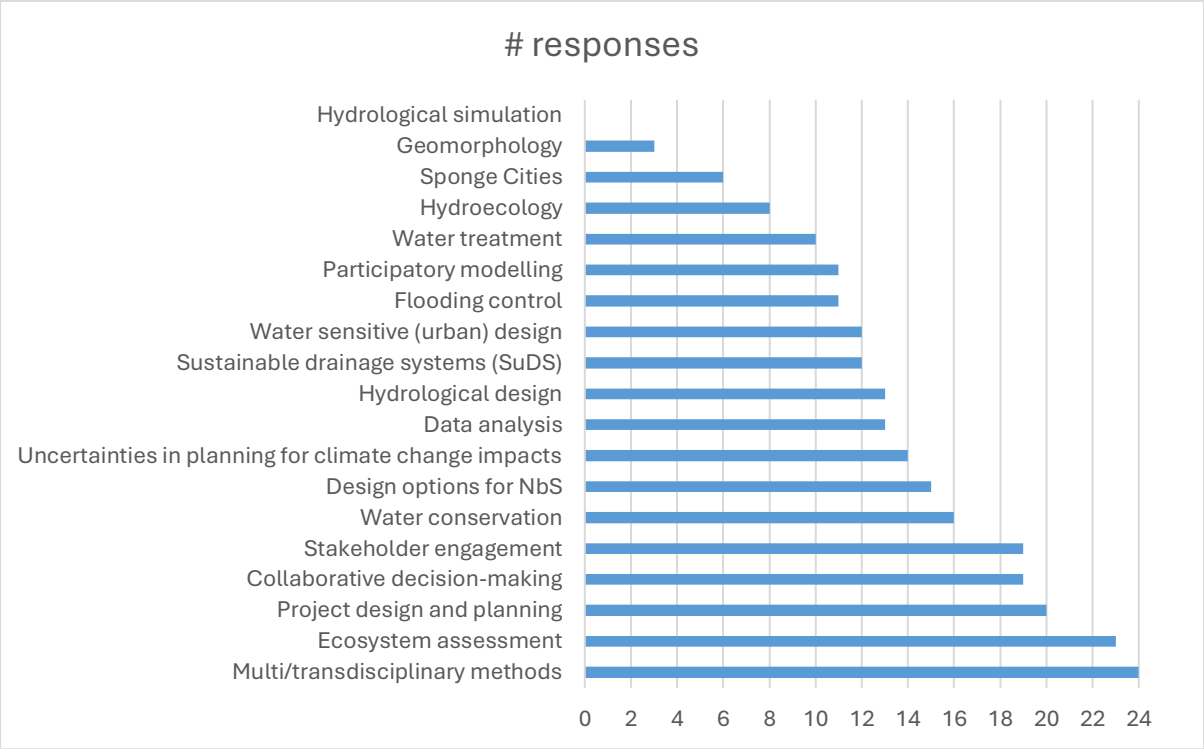

Figure 1. Skills selected for prioritisation in relation to NbS-focused education and training by 33 key respondents

Under 'other' skills, respondents added ecology, anthropology, political ecology, environmental chemistry/water quality, critical thinking skills, systems thinking and root cause analysis (implement the correct NBS for the problem that needs addressing).

The survey also provided individuals to leave open comments on NbS education in engineering, built environment-related disciplines, and environmental science degree. Here is a collation of responses that we received (some key comments are highlighted):

- Your list of areas contributing to NbS training was very science heavy - it needs more social science and engineering options, then ask for "top 5" -so there is more scope in the answers you get.
- **Should not be seen as another form of technical solution, but a social-ecological pathway that needs to be adaptable and beneficial.**
- **Factor in Disaster Risk Reduction, Climate Change Adaption and Risk Informed Development in all these subjects.**
- I think we need to **integrate interdisciplinary approaches, hands-on fieldwork, and community engagement into curricula to bridge theory and practice**, fostering holistic

understanding and practical application of NbS in engineering, built environments, and environmental science.

- **Green buildings and the greater environment help reduce negative impacts** on the natural environment by using less water, energy, and other natural resources, employing renewable energy sources and eco-friendly materials, and reducing emissions and other waste. **Integrating these principles into the curriculum is critical** to building academic capacity
- **Scientists and engineers mostly differ in approaches, so it is important that disciplines work together**
- Can't speak for engineers, landscape planning needs to be done, not just dealing with one problem at a time.
- **Civil engineers need this training urgently**, less so for environmental and water science practitioners
- To the best of my knowledge, **public consultation and transdisciplinary interaction are** not taught or modelled in any of the built environment professions, this is something that is **blatantly lacking in convectional built environment projects** "public participation" consultations are often about convincing the interested and affected parties that the professionals know best. There is also the difficulty of engaging with the really affected parties who are disenfranchised and thus unlikely to be included in formal consultations
- **Include practical experiences, case studies, industry collaboration, interdisciplinary approaches**, internships, and networking to enhance students' understanding and skills in NbS. Continuous learning, evaluation, and feedback are important for program improvement.
- The training needs to be linked to active ongoing research in South Africa, with training information updated as we learn more.
- I think an introduction of possible NbS to industries would assist with the development of impactful Corporate Responsibility initiatives.
- 1. Build an appreciation for the value of nature in its own right; **2. Demonstrate how NbS can deliver comparable or superior performance to grey infrastructure; 3. Identify how co-benefits accrue, and to whom they accrue; 4. Develop methods for integrating ecological analysis into design; and then for integrating natural capital into the business case process.**
- It should be an integral part of any training
- This concept is a great in inclusivity approach and recognizes local inputs. It is worth testing at catchment level to answer specific challenges and stakeholder needs. Again, a buy-in by locals is fundamental for sustainability. Nothing about us without us is a true and popular term used in South Africa post-apartheid
- **Need to move to the point where the science is sufficiently developed that the benefits of NbS can be accurately modelled, and ultimately measured in the field.**

Gaps and Challenges in South Africa

The following is a summary of the gaps and challenges identified by the interviewed participants, including suggested training related to educational needs, and recommendations for implementation plans. Many of these align with the courses we have chosen under the NbS4AfrRes project, and **where there is overlap between the suggested need and our project's work, the text has been highlighted in bold**.

- **Environmental and Hydrology:**
  - Importance of technical skills in wetland soils and hydrology.
  - **Balancing specialized knowledge with broader environmental understanding.**
  - Climate change is not being adequately integrated into curricula or taken seriously enough in the field, particularly in areas like landscape management, catchment management, and natural resource management.
  - Teaching and understanding toxicology and metabolization of chemicals and toxicity of metabolites and chemicals through the ecosystem.
  - **Graduates need to be environmentally conscious.**

- **Stakeholder Engagement:**
  - **Relational skills for effective teamwork and leadership in multidisciplinary environments.**
  - **Deepened understanding of and skills in effective stakeholder engagement**
  - **Integrating ethical and value-based considerations into professional practice.**
  - ESDD: Environmental and Social Due Diligence Specialists – Auditors of the social, economic, environmental contributions of a development are lacking in South Africa. Most specialists have learnt on the job. (for practitioners)

- **Infrastructure design in context of climate variability**
  - **Data access, data analysis and critical thinking**
  - **Uncertainties for planning for climate change impacts; project design and planning; stakeholder engagement, participatory modelling; multidisciplinary methods.**
  - **Water-sensitive urban design, sponge cities and NbS options. Professional accreditation bodies could play a crucial role in addressing climate crises by ensuring that it is part of the accreditation process and ensuring these aspects are implemented effectively.**
  - **Civil engineers don't fully understand the impacts of the infrastructure they are responsible for.**

- Greater understanding of environmental economics, cost-benefit analysis, risks and challenges associated with NbS implementation, and the ability to scale and transfer NbS to other sites.
- **Addressing challenges in environmental impact assessment processes.**

- **NbS design and implementation (infrastructure / development projects)**
  - **Engineers need to understand how to bring NbS into project design and implementation**.
  - **Environmental Scientists and Engineers need to understand each other in terms of ways of thinking and practice, to be able to work together effectively on NbS projects.**
  - **Local Ecological Knowledge can be valuable and effective in the design and implementation of NbS**.

- **Project planning, management and decision making**
  - Project planning and management skills at university level for project design.
  - **Systems thinkers / 'Big picture thinkers': Able to understand and integrate the different components of a social-ecological system, and effectively make decisions that will minimise impacts and improve well-being of the 'system' in review**.

Summary of survey interviews with professionals and key decision makers – Senegal

Ten (10) individuals were interviewed in Senegal to gather in-depth feedback on the questions covered in the survey, with particular focus on gaps and challenges. To gather additional information on gaps and challenges, sixty (60) online survey respondents were selected to complete this analysis based on their roles as decision-makers or professionals. Therefore, a total of seventy (70) key informants are included in this report on gaps and challenges in nature-based solutions related to education and training, including:

1. **Key participants and decision-makers in Senegalese HEIs :**
   - One administration and technical coordinator
   - One director of studies
   - One dean of faculty of Science and Technology
   - One assessor
   - Heads/Directors/academic staff of various departments and institutions (Higher education, environmental sciences, Geology, Plant biology, Geography, Medical sciences)
2. **Government officials**
   - One Representative of the Ministry of the Environment and Ecological Transition
   - One Representative of the Ministry of Land and Air Transport and Infrastructure
   - One Representative of the Ministry of Infrastructure, Land and Air Transport/Directorate-General for Road Infrastructure and Accessibility
   - One Representative of the National Public Health Laboratory
   - One Representative of the Flood Prevention and Management Directorate
   - One Representative of the National Agency for Spatial Planning
3. **Professionals**
   - One project manager, road engineer
   - Eleven professionals in the field of built environment or environmental sciences
   - One International Officer Senior Specialist in Water and Sanitation
   - One agricultural research
   - One Project manager of a structure in collaboration with the Ministry of vocational training and vocational training centers
   - One microbiologist
   - One Engineer Biological and Sanitary Engineering
   - Two Health professionals
   - One Biologist in a medical analysis laboratory
   - One Geomatics Engineer
   - One Expert in an international organization
   - One Climate expert and associate researcher
   - One Community Development Officer

- One Construction company manager, company administrator.

Summary of priorities identified by online survey respondents

The survey asked *which skills should be prioritized in relation to NbS -focused education and training in the country(-ies) where you are working to address complex environmental challenges?* The respondents were provided a checklist from which they could choose more than one response and add items that were missing in the checklist. The figure below shows the choices selected by the 70 key respondents who work in Senegal. Like the South African survey, note the importance of multidisciplinary methods and stakeholder engagement.

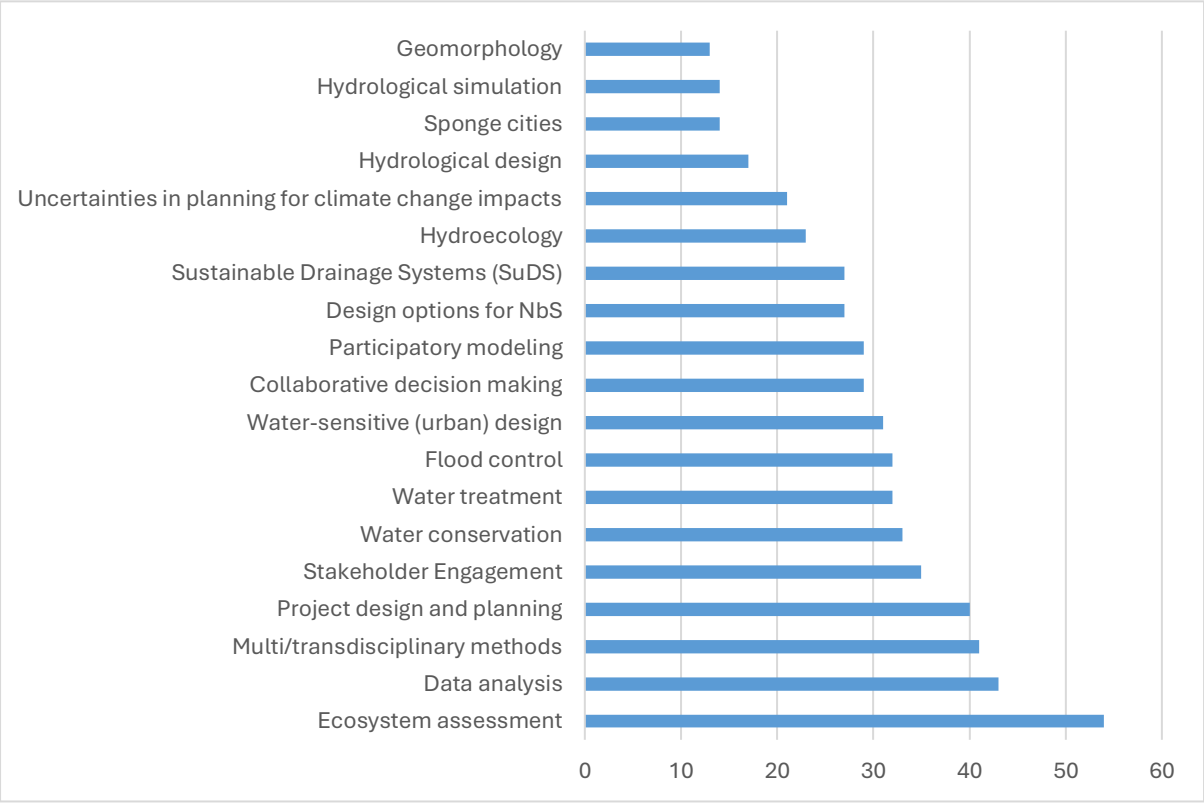

Figure 2. Skills selected for prioritization in nature-based solutions education and training by 70 key informants

Under 'other' skills, respondents added Ecohydrology, Renewable energy/Recycling of domestic wastewater, Agroecology, aquaponics, Green building technology, methanization, valorization of by-products and Ecological engineering.

The survey/interviews also allowed people to leave open-ended comments about natural science education in engineering, built environment disciplines, and the environmental science degree. Here is a compilation of the responses we received:

- Using our universities' websites for ecological transformation experiments

- What the Institute of Environmental Sciences (ISE) in Dakar is doing is a good direction, it just needs to update certain modules
- The practical aspect should be taken into great consideration
- Here, it is necessary to integrate the lessons of geomatics to help with better decision-making.
- I suggest teaching the landscape and housing development models of small communities and their techniques for protecting fragile sites, valuable sites and the particularity of habitats and construction materials, the mixtures and associations of materials that defy time and the severity of the environments, the endogenous techniques for adapting to climatic conditions.
- **Develop and implement climate change adaptation plans that include nature-based solutions**, provide coaching and technical assistance to young people for the establishment of value chains on a circular economy model
- Take stock of existing standards and identify the key points to be addressed in terms of implementation and translate them into training (module).
- Raising awareness among the population, implementing related policies, and punishing related crimes or offences
- **To popularize the concept, we must not limit ourselves only to academics. We must also reach out to trainers from preschool to secondary school.**
- Being from the Democratic Republic of Congo, I would like to participate to protect our environment: water, forest and environment.
- It is of **vital interest that such trainings are implemented in Africa**, especially in sub-Saharan Africa where the rate of infections due to environmental degradation is very high. Thus, the contribution of these engineers could alleviate the situation.
- The body of research must be included in all institutions
- As part of water treatment, at the Dakar Polytechnic School, we had a project for water treatment using moringa (endogenous knowledge)
- **Take into account the interdisciplinary dimension in training**
- Integrate technical disciplines (Remote Sensing - GIS, etc.) to measure the state of the place, the evolution of natural components (vegetation, water, pollution, erosion)
- I think we need to identify endogenous techniques and work to optimize them for application.
- **NbS training must also include the concepts of ecology, ecohydrology, and the application of the concept of ES (Ecosystem Services)**.
- A good knowledge of the environment, the object under study and the recipients. Have local databases and develop teaching modules taking into account the capacities of the recipients to support the solutions proposed
- **Suggest that NbS be integrated into the teaching of urban planning**, particularly the development of Urban Master Plans.
- What is the difference between eco-construction and NbS ?
- We will need to think about global content to teach in all disciplines, and specific content for specialties.

- For example, in **the field of the built environment, with global risks, we can no longer design our buildings as we did forty years ago**. Our engineers must offer us integrated solutions to make our homes more airy and lit in terms of green energy. We must also take into account the reuse of wastewater through an integrated management system. It is therefore important to train our engineers in this sense and in different fields.
- I suggest that we avoid anything that is theoretical training. The training must be professional and where we will bring in different types of actors as well as populations who will share their knowledge of adaptation strategies in the face of CC.
- **These things basically need to be integrated into our engineering training curriculum** in addition to what is already provided/is already good. But it could be very beneficial to our students. Especially since these are current topics. All the programs that are currently being developed do not overlook the sustainable development/nature-based solution part. So anything that could be used to further improve the culture and knowledge of students in this area would only be beneficial, so I think that the EPT would be ready to move in this direction. Perhaps initially, the integration of nature-based solutions as a complement while waiting to set up a program on this.
- As engineers or as researchers, it is something that we minimize. But it is very important especially currently with the negative effects that we feel. With the solutions that are developed I think that it is something to encourage. This is why we will have to do a lot of awareness raising to make people understand the relevance of these themes in teaching, in educational projects and in research.

Gaps/Challenges and Recommendations from Participants in Senegal

Here are the gaps and challenges identified by seven interviewed participants, including suggested trainings related to educational needs and recommendations for implementation plans. Many of these align with the courses we have chosen under the NbS4AfrRes project, and **where there is overlap between the suggested need and our project's work, the text has been highlighted in bold**.

Gaps/Challenges

Lack of Knowledge and Training

- **Lack of knowledge on multi/transdisciplinary methods.**
- **Lack of training in participatory modeling.**
- Lack of mastery of practical tools.
- Lack of knowledge of the ecosystem.

Resource and Tool Issues

- Lack of means for data analysis; reliable analysis tools are lacking.
- Ecosystem assessment: not enough tools.

- Problem with the means of research, analysis and processing of data. The staff is not well trained for the development and exploitation.

Project Planning and Design

- Lack of rigor in the design and planning of a project, especially planning.
- **Uncertainties in planning for the impacts of climate change.**

Sustainability and Synergy

- **Sustainable practices not systematized.**
- No synergy between state structures in charge of promoting sustainability and university actions in terms of training, leading to the absence of formal programs to integrate sustainability.
- Lack of explicit consideration of sustainable development in strategic development plans, particularly in the university's missions (teaching, research, and service to the community).

Engagement and Applied Research

- **Stakeholder engagement.**
- Lack of research based on flood control.

Recommendations

Sustainability Training and Programs

- **Integrate more courses and awareness on sustainability and ecology, considering nature as a solution**.
- Create specific diplomas and masters in sustainable development, depending on the faculties and inter-university programs.
- Associate these training courses with research centers to enrich teaching methods

Practical and Technical Skills

- Train students from the first year in data manipulation and analysis, biostatistics and computer science.
- Establish practice-oriented professional licenses in different fields.
- Develop a consensus on core sustainability competencies for all universities.

Resilient Development and Risk Governance

- Design resilient development and risk management strategies.
- Strengthen the capacity of institutions to assess and govern risks to create academic and national centers of excellence.