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Coordinator: Xavier Le Roux - Fondation pour la Recherche sur la Biodiversité (FRB)

BiodivERsA
Strategic Foresight workshop
'Nature-Based Solutions in a BiodivERsA context'
Brussels June 11-12 2014

Workshop Report

WP2: The European biodiversity research landscape and science-policy integration
WP leader: Henrik Lange – The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas)

Task 2.3: Analyse research agendas and identify knowledge gaps and research priorities
Task leader: Estelle Balian/Hilde Eggermont (BelSPO - Belgian Science Policy Office- Belgian Biodiversity Platform)

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1 Introduction

The BiodivERsA consortium (ERA-Net funded by the FP7)[1] regularly develops mapping and foresight activities to **characterize the research landscape and investigate key future research challenges and policy needs for biodiversity and ecosystem services at European level**.
In 2013, several meetings were organized in support of the implementation of the *EU Biodiversity Strategy to 2020*, including:

- **DG Research and Innovation/EPBRS workshop "Investing in Innovative Research for Nature and our livelihoods: Strenghtening the research strategy to reinforce the ERA on Biodiversity"**, held on April 11-12 in Brussels. The aim of the workshop was to identify ways forward to consolidate the ERA on biodiversity and ecosystem services, and to explore the research priorities in the current research and environment policy context (report[2])
- **DG Environment/Alter-Net conference "Science underpinning the EU 2020 Biodiversity Strategy"**, on April 15-18 in Ghent. The aim of this conference was to discuss the current science underpinning the implementation of the 2020 strategy, addressing all six targets (report[3]).
- **EPBRS Irish Presidency meeting** on May 15-17 in Dublin, Ireland. This meeting focused on (i) Research to support the implementation of Article 17 of the habitats directive and target 1 of EU2020 Biodiversity strategy; (ii) Research to support the implementation of the EU biodiversity strategy (report[4])

These activities and the BiodivERsA horizon scanning exercise intended to serve the implementation of the *Convention on Biological Diversity (CBD) Aichi Targets*[5] and the tightly linked *EU Biodiversity Strategy to 2020*[6], which are setting the scene for priority policy and practice actions for the next 20 years and will most likely require sound scientific advice.

Along with the *EU Biodiversity Strategy to 2020*, the "**nature-based solutions**" concept has been emerging, calling for renewed needs of knowledge and actions. As a consequence BiodivERsA partners considered this topic as a major emerging issue for the biodiversity research community, and organised a **strategic foresight workshop to identify research needs that are relevant to Nature-Based Solutions**.

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[1] BiodivERsA is a network of national funding organisations promoting pan-European research: http://www.biodiversa.org
[2] Report downloadable from: http://www.epbrs.org/event/show/35
[3] Report downloadable from: http://www.alter-net.info/outputs/conf-2013
[4] Report downloadable from: http://www.epbrs.org/news/show/31
[5] http://www.cbd.int/sp/targets/
[6] http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure%20final%20lowres.pdf

In the background documents and during the workshop, the current definitions of the "nature-based solutions" (NBS) concept were presented:

NBS refers to the ***use of nature in tackling challenges such as climate change, food security, water resources, or disaster risk management****, encompassing a wider definition of how to conserve and use biodiversity in a sustainable manner. By going beyond the threshold of traditional biodiversity conservation principles, this concept intends to additionally* ***integrate societal factors such as poverty alleviation, socio-economic development and efficient governance principles****.*

Research on NBS should thus clearly demonstrate which new knowledge generated will help tackling which challenges.

The International Union for Conservation of Nature (IUCN) is currently developing guidance on what type of interventions could/ should/ should not be considered as a "nature-based solution" (NBS). Other groups are also discussing the definition of the concept of NBS such as the Horizon 2020 Advisory Group (AG) for Societal Challenge 5 'Climate Action, Environment, Resource Efficiency and Raw Materials'[7].

Examples of nature-based solutions are provided below:

- Naturally connected floodplains and riparian ecosystems can provide flood protection for millions of people who are likely to experience increased flood risk
- Forest protection and reforestation can provide clean water, reduce flood risk and support carbon sequestration.
- Deep-rooted, nitrogen-fixing plants can naturally replenish soil nutrients in systems helping to maintain access to food supplies. Other plants can help filter sediments and nutrients keeping our waters clean and available for human consumption while enhancing carbon sinks.
- Mangrove forests provide protection services from coastal erosion and protect human lives in the face of severe storms while providing nurseries for fishes which can feed coastal populations of people
- Well-managed and conserved grasslands can provide forage for livestock while storing carbon in above- and below-ground biomass.

Yet, more research and adequate implementation strategies are needed to investigate nature-based solutions, and to further explore how societies can avoid degrading their natural environment and the wealth of valuable benefits it provides. As a consequence, the Horizon2020 program of the European Commission[8] (EC) is expected to tackle nature-based solutions in its 2016-2017 phase. Consultations are thus being set-up at a pan-European scale under the umbrella of the EC.

[7] http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=2924

[8] http://ec.europa.eu/programmes/horizon2020/en

Objectives of the BiodivERsA nature-based solution workshop

As the concept of nature-based solutions is rising on the research policy agenda, BiodivERsA organized a horizon scanning workshop, providing an opportunity for BiodivERsA project scientists, as well as for programmers and research funders who are members of BiodivERsA (including several Ministries) to:

- Learn more about nature-based solutions through discussions with policy makers and a range of stakeholders (NGOs, businesses, practitioners, etc.)
- Assess to what extend nature-based solutions have already been addressed in BiodivERsA-funded research projects
- Discuss how these nature-based solutions could be further investigated in the field of interest of participants. Such an exercise could produce lists of potential research priorities that could be considered by BiodivERsA's strategic agenda
- Further strengthen collaboration with other BiodivERsA-funded research projects.

It was expected that the workshop would help identifying potential research priorities that could be considered by BiodivERsA's strategic agenda in the future. It was an opportunity to involve scientists and stakeholders in the research development process from the start (identifying gaps of knowledge), and initiates a regular consultation with the project researchers to ensure they can also contribute to the upstream discussions on emerging research issues.

2 Methodology

The workshop was organized in two half days with a first session of framing presentations and panel discussions followed by a session of moderated round table discussions[9]. The workshop started with a short ice-breaker identifying main concerns and expectations from the participants that were presented at the beginning of the next morning to see how these were being addressed by the on-going discussions.

The keynote presentations gave an opportunity to better understand the concept of nature-based solutions as defined, used and illustrated by different actors and points of view. After the series of keynote presentations, the speakers took part in a panel discussion that allowed exchanges on opportunities and challenges of using the NBS concept, as well as its relation to other terms such as 'ecosystem-approaches' and 'green infrastructures'.

For the first round of table discussions organised in the afternoon of June 11 were organised around five topics:

- Mitigation of and adaptation to climate change

[9] See Annex 1: Programme

- Water and Food production
- Soil, forest, land management
- Disaster risk management
- Social and economic innovation

These discussions focused on identifying *examples of possible Nature-based solutions* related to each proposed topic from participants' expertise and from BiodivERsA projects.

The following rounds of discussions on June 12 focused on identifying *knowledge gaps and potential research priorities related to these Nature-Based Solutions.* The same five topics were addressed and an additional group of discussion specifically dealt with "*Framing the concept of NBS and identifying challenges and opportunities of using the NBS concept*".

3 Results

3.1 Keynote presentations[10]

Adrian Peres (European Commission Directorate-General for Research and Innovation) gave an overview of the potential links of Nature Based solutions to Horizon 2020, summarizing the results of the first report of the Horizon 2020 Advisory Group (AG) for Societal Challenge 5: 'Climate Action, Environment, Resource Efficiency and Raw Materials'. In this report **Nature-based is referring to: "inspired by, using, copying from or assisted by Nature" and with the aim of bringing economic, social and environmental benefits all together**. These NBS should have some criteria including:

- Build in resilience: providing the ability to bounce back after perturbation.
- Reversibility: designing systems that are reversible where possible, that are locally attuned (in a geographical but also a social sense) and energy and resource efficient.
- Designing NBS in ways that take into account the larger, systemic context and that maintain or augment natural capital where possible.

These NBS could address major challenges such as: re-naturing and greening cities, restoring degraded ecosystems, adapting to climate change, improving human health and well being, reducting disaster risk, guiding land use management, etc.

Chantal Van Ham (International Union for Conservation of Nature) introduced the IUCN definition of NBS with seven principles[11]:

1. The intervention delivers an effective solution to a major global challenge using nature
2. The intervention provides biodiversity benefits in terms of diverse, well-managed ecosystems
3. The intervention is cost effective relative to other solutions

[10] Downloadable from http://www.biodiversa.org/671

[11] https://cmsdata.iucn.org/downloads/iucn_programme_2013_2016.pdf

4. The rationale behind the intervention can be easily and compellingly communicated
5. The intervention can be measured, verified and replicated
6. The intervention respects and reinforces communities' rights over natural resources
7. The intervention harnesses both public and private sources of funding.

Thereafter, it was illustrated how NBS could be employed for climate adaptation, disaster risk reduction, drinking water supply, and in urban environments. Finally, the need to bridge the gap between science and policy was highlighted.

After introducing the concept of 'Green Infrastructures', **Victor Beumer** (Deltares) illustrated the potential of "nature-based engineering" in the context of water management. He pointed to four types of nature-based engineering: (1) using natural processes for multi-functionality and ecological functioning, (2) using natural processes for non-ecological functions, (3) ecological optimisation and/or integration in the landscape, and (4) mimicking natural processes in a technical/engineering design. He also underlines the need to validate concepts. Some key implementation principles identified include:

- Demonstrate the functionality of the NBS and the value for nature
- Tell the story around it to engage local stakeholders
- Look at how to cope with local legacies
- Include all stakeholders from the start of a (spatial) design process
- Design a valid business case
- Monitor to improve.

Xavier Le Roux (BiodivERsA coordinator) introduced the BiodivERsA ERA-net and its achievements, and why Nature-Based Solutions have been considered as a major issue to be explored by BiodivERsA for its future activities. He then reported on the recent consultation of BiodivERsA Project Investigators[12] (PIs) who replied to an online questionnaire on nature-based solutions following a request of DG Research and Innovation. The questionnaire assessed to what extend the research supported by BiodivERsA addresses/could better address the issue of NBS. There was a high level of response to the questionnaire (i.e. 22 out of the 25 projects funded since 2010 answered). It appears that many projects funded by BiodivERsA so far have clearly focused on NBS relevant issues and several could even be identified as NBS projects. One of the main comments highlighted by the researchers was the need to remain realistic and consider that there will be few 100% win-win situations (i.e. where environmental, social and economic benefits are simultaneously met) so that trade-offs will have to be explored and characterised to help decision making. In particular, NBS can limit short-term economic gain and there is a need to revise the assessment of economic benefits with a longer term perspective. They also pointed to the need to change management and governance of socio-ecological systems and to accept complexity, uncertainty and diversity.

[12] Managers of BiodivERsA funded projects

Thomas Elmqvist (Stockholm Resilience Centre; BiodivERsA URBES project[13]) illustrated the potential of NBS in the urban context, as derived from the results of the BiodivERsA-funded project URBES. The project aims to bridge the knowledge gaps on the links between urbanization, ecosystem services and biodiversity. It addresses, amongst others, the potential of cities for climate change migitation, adaptation to change, risk management and public health provision.

James Hardcastle (IUCN) presented IUCN's work in the 'Blue Solutions' initiative, a global platform that aims to synthesize lessons learnt and best practices in marine and coastal management. Using examples from Marine Protected Areas (MPAs) in Indonesia and the Salomon Islands, he illustrated how the Blue Solutions project aims to enhance the evidence base of MPAs while fulfilling human needs and conserving nature.

Several questions were raised during the panel discussions, such as:

- How to avoid that NBS gets confined to the environmental sector (how do we reach beyond)?
- Why do NBS need to be innovative? What does it bring to society?
- What are the links between the NBS concept and others, such as 'ecosystem approaches', 'ecological engineering', 'green and blue infrastructures', and 'Natural capital'. Maybe we are too hooked on terms? We use different terminologies but aren't they all serving the same goals?
- Why do we actually need this new concept? What has happened with the concept of "sustainable development"?
- What is the link between NBS and bio-economy?
- How can we involve the different stakeholders in the process?
- What aspects of nature are considered in NBS? Will implementation of NBS always mean better conserving or improving biodiversity?

In their responses, the speakers pointed out various elements, such as the need of looking for synergies between the various approaches; re-using (maybe revisiting) some existing ('old') techniques in NBS applications; using different languages (terminologies) when addressing different audiences; doing research on the concept; changing our behaviour (culture shift, including for scientists and stakeholders); raising awareness by demonstrating the potential of NBS for the environment/economy/society; and need for dissemination of research findings, amongst others.

3.2 Expectations & Concerns

On the first day, participants were asked to identify their main expectations and concerns about the workshop.

Participants expectations were mainly related to better understanding and learning about the concept of NBS, how it can be implemented, which challenges

[13] http://urbesproject.org/

it could address and how it can help reach multiple benefits. Participants also expected to better understand the links with other concepts such as bio-economy, green infrastructures, natural capital, etc. They were also interested to see how this concept would influence future funding. Other expectations included listening to new ideas and networking with others from different fields of expertise.

Participants concerns for the second day were mainly related to the fear of having superficial discussions leading to nothing concrete, which would leave them "lost in brainstorming". The concerns were also targeting the concept of NBS itself, which for some participants, felt as a repackaging of other (existing) terms, blurry, unclear, and nothing more than a political buzzword. Many participants highlighted the need of looking at trade-offs as NBS is not *THE solution for all issues (i.e. it societal and political choices will not be avoided given the trade offs that will often exist between different facets of an NBS approach)* and its application needs to be framed. Others highlighted the risk that the workshop would focus too much on the definition of the concept of NBS, and therefore not allowing to explore its potential. Some questioned whether the audience might be too broad or on the contrary too biased towards natural sciences.

3.3 Results of the round table discussions

The following reporting is based on the results of the group discussions. We report the main results in terms of (i) framing the emerging concept of nature-based solutions and (ii) research priorities identified. We decided to structure the results in a format that follows a gradient from more general comments (made in various discussion groups in addition to the group dedicated to framing the concept) to more practical specific proposals of nature-based solutions linked to some specific topics. Likewise the second section on research priorities compiles research recommendations from all groups from the more generic to the more specific.

3.3.1 Framing the concept of nature-based solutions (NBS) and its applications

The ideas listed below come from the various groups as the first discussion session showed that many participants judged that it was premature to jump into concrete examples of NBS while the concept itself still needed some framing. In addition, we also report here the outputs from the group that specifically discussed the framing the concept (group 6 June 12)[14]

[14] All notes from discussion groups are available in Annex 2

3.3.1.1. Framing considerations regarding nature-based solutions

Main framing conditions to take into consideration when developing nature-based-solutions:

- ***A large part of the NBS, solutions should be based on the integration of several levels of diversity within a system*** (see Thomas Elqmvist's presentation) which empowers the socio-ecological systems in terms of sustainability, and resistance and resilience capacity to global changes and extreme/unexpected events. E.g: a forest, which is diverse (from a genetic point of view, age structure, community composition and habitats), could be more prone to resist to hazards like pests, severe drought spells or storms.

- ***A NBS should account for multiple interests in particular economic, environmental, and societal ones,*** as it should be a tool to provide input for different policies through the understanding of social and economic benefits in addition to environmental ones. NBS research should thus provide knowledge supporting choices and decision making by stakeholders, including policy-makers, through the understanding of social and economic benefits and drawbacks in addition to environmental ones. A key word here is sustainability, because NBS should correspond to sustainable solutions.

- ***Identification and documentation of the possible synergies and trade-offs between the multiple economic, environmental, and societal interests is at the heart of the identification and implementation of robust and efficient NBS***. The identification of trade-offs can be facilitated by the results of a risk assessment.

- ***Other types of knowledge should be included when exploring NBS***, in particular one cannot ignore 'local knowledge' in identifying NBS.

- *The NBS concept requires a* ***clear link with other concepts such as Green and Blue Infrastructures (GBI), Ecosystem based adaptation to climate change, Ecosystem approaches, Natural Capital, and Ecological Engineering***. For instance, GBI can be part of NBS or NBS can be used to build adequate GBI.[15]

Innovative social processes:

Innovative social processes are needed for NBS implementation but also to a large extent when conducting NBS-relevant research. Specific NBS are indeed tightly

[15] The research programming process should thus make the links between these different concepts very clear to ensure consistency and avoid redundancy or confusion between programming actions at EU and national scales.

linked to the social process needed to identify, assess and organize solutions. The quality of the solutions is thus considered to be dependent on the quality of these social processes, e.g. regarding involvement and support of a diversity stake- and knowledge-holders. More particularly, the following points have been identified as being crucial for successful NBS implementation:

- ***Involve relevant stakeholders from the very beginning of the nature-based solution process***, in particularin the following steps: (i) Identification of the problem and possible NBS (ii) Identification of the natural and social processes occurring; (iii) Knowledge building; and (iv) Information gathering and dissemination (see below). In particular, interdisciplinarity/ transdisciplinarity should be a Nature-Based Solutions rule.
- ***Knowledge on NBS needs to be made widely available and shared.*** In this context, how results of NBS-relevant researches are reaching out to their audience is critical and requires that the message is reframed depending on the targeted audience. Both good and bad examples should be reported from various geographical areas (e.g. not just in developing countries but also in developed ones). NBS are often case-specific and may not be easily transferred to other settings, but some ideas can be useful in various contexts.

Avoid misleading conceptions and approaches when framing the NBS topic:

- ***NBS are referred to as 'Innovative' but should not only refer to 'new' solutions*** : NBS might be a new concept but it encompasses already existing ideas; there might be innovative components in "old ways"; it is important to learn from the past and look back at what has been done to identify potential future NBS.
- ***NBS are not THE solution to all problems, and will not necessarily offer simple solutions to complex problems. It is important to clearly define the problem that could be targeted.*** For complex problems, the views of a range of stakeholders might be collected, and negotiation involving relevant stakeholders might be organised to avoid only simple solutions which would not tackle the whole issue. Depending on the problem identification, NBS can be looked at through building blocks (e.g. landscape approaches).
- ***Do not propose and implement a NBS without an associated sound risk assessment*** (and possibly a *Plan B*) taking into consideration a life cycle analysis and the precautionary principle. For instance, NBS need to account for future environmental changes and especially all proposed NBS should be evaluated for being "climate proof" and "biodiversity proof"**.** The analysis should cover the full set of impacts (Climate Change, Biodiversity, Social well-being) but also current lines of production to avoid « wrong » solutions e.g. biofuels. Indeed, a NBS solution may – at some point – become a problem (cf. pest control> invasive species).

3.3.1.2. Proposed typology for nature-based solutions

BiodivERsA workshop participants proposed to categorize NBS along two gradients (Figure 1):

(1) "how much engineering of biodiversity and ecosystems is involved by a given NBS"; and
(2) "how many services and stakeholder groups are targeted by a given NBS ". It is expected that the higher the number of services and stakeholder groups, the lower the capacity to maximize each service and fulfil the specific needs of a particular stakeholder group (Figure 1).

Using these two gradients, 3 main types of NBS were defined:

1- NBS Type 1: They consist in better using existing natural or weakly managed ecosystems; the ambition here is to better use them, delivering a range of ecosystem services in and outside these ecosystems while minimising the intervention on the systems themselves.
2- NBS Type 2: They correspond to the definition of management rules to develop sustainable and multifunctional ecosystems (possibly intensively managed) and better deliver selected ecosystem services.
3- NBS Type 3: They consist in managing ecosystems in very intrusive ways or even creating completely new ecosystems.

Participants identified some examples of NBS (Figure 2) for each type and some links with existing BiodivERsA projects (Figure 3)

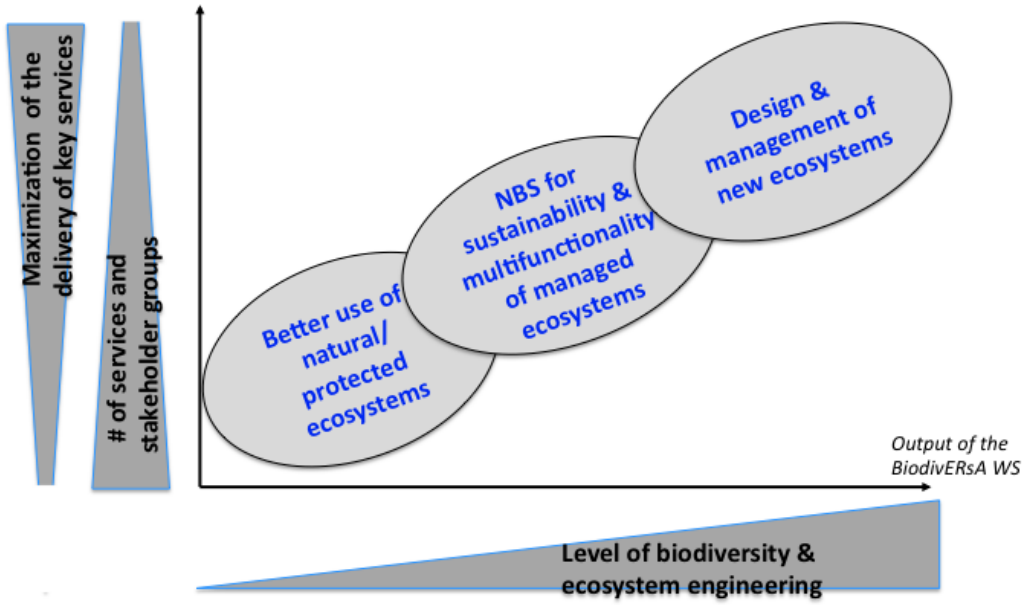


Figure 1 : Schematic representation of the range of NBS approaches to be considered. Three main types of NBS are defined, differing in the level of engineering applied to biodiversity / ecosystems (X axis), and in the number of services to be delivered, the number of stakeholder groups targeted, and the likely level of maximization of the delivery of targeted services (Y axis).

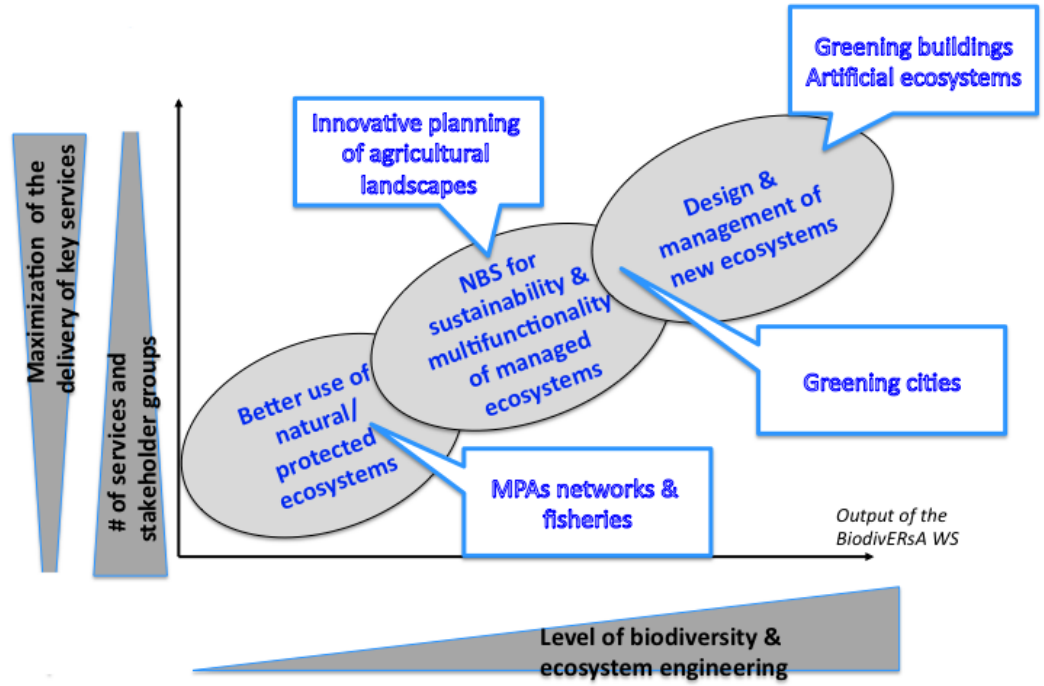


Figure 2 : Some examples of NBS located in the schematic representation of Figure 1

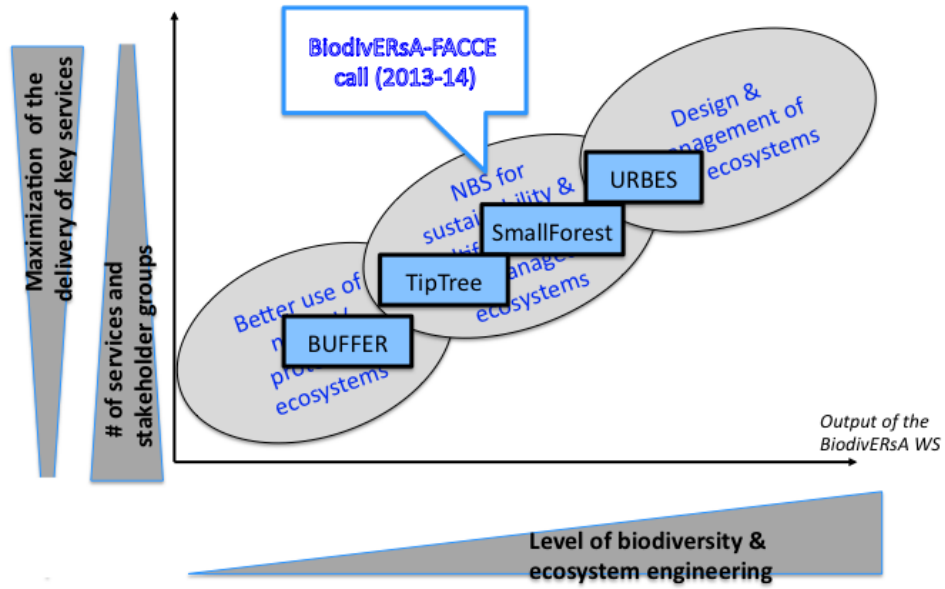


Figure 3 : Some examples of NBS-relevant research projects funded by BiodivERsA located in the schematic representation of Figure 1. The type of NBS addressed by the BiodivERsA-FACCE call launched in late 2013 is also indicated.

3.3.1.3. Implementation of the concept of nature-based solutions to contribute to social and economic innovation

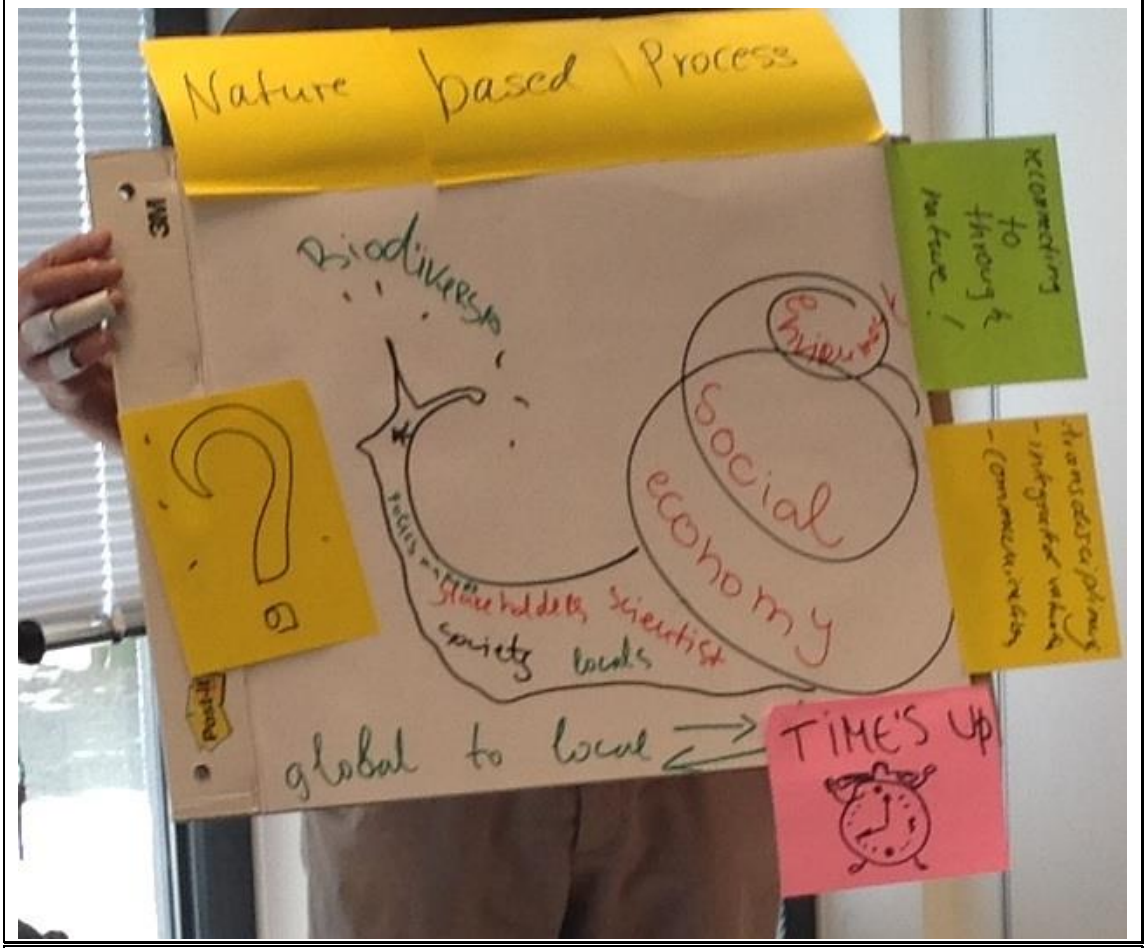
- ***Up-scalability of local NBS and stakeholder importance***
  Nature-based solutions should be considered in relation to the scale at which they can be applied, and whether they could be implemented on a large scale and in a sustainable way. The question arised: What is more efficient - several local projects or a few global ones? In any case, the nature-based solutions (especially at local level) will need to use "the language of the community". They should be based on the principle of 'Think globally act locally". There is a need to ensure the satisfaction of the stakeholders who participate in these actions.

- ***The role of time pressure when choosing technological versus natural solutions***
  A major issue is the time frame in which nature-based solutions can be implemented and provide an added value. On the short term, technological solutions might often be considered more efficient. This raises the question of who decides on the trade-offs and what timing should be considered; whether actors are ready to accept time frames of nature-based solutions (i.e. nature decides on time frame); and what compromise is feasible, maybe by using nature friendly technologies?

- ***Raising awareness and building capacity in time***
  Adequate implementation of nature-based processes/solutions requires awareness raising and capacity building which are time consuming, while problem solving is usually urgent. A collaborative and structured approach is needed to find a pragmatic balance between broad involvement on the one hand, and coordination (time) costs for organizing such process on the other hand. If stakeholders and policy representatives only get together when the problem has already manifested itself, setting up such process may take too much time in order to address the problem adequately. A pro-active approach would build such collaborative and structured capacity before the problems occur so that upcoming problems can be addressed timely.

- ***Changing mindset of how society evolves and contributing to reconnecting to and through Nature***
  To be successful, nature-based solutions/processes should contribute to "reconnect to and through nature" so that people change mindsets and behaviors. Indeed, NBS can also enhance social cohesion: an example was mentioned of people jointly planting trees (e.g. in disaster areas) enhancing social cohesion and helping them to deal with their grief and to refocus on forward looking instead of mourning about the disaster that struck them. Also, working with nature may offer jobs to a lot of unemployed people.

The snail: illustrating the framing and implementation of NBS



- The body of the snail is made up of various stakeholders (scientists, locals, society and policy makers). They are the driving force to make the snail move
- The antennae are scientists, research organizations, and funding networks as BiodivERsA. They are sensing and giving information to the various stakeholders
- The shell represents the environment, society and economy. The upper curve is the smallest one (environment) but also the origin of the structure (that is the first part of the snail house growing). Economy is the largest one, a driving force.
- The snail moves into a direction. The destination can be based on many different things and goals.
- Time pressure is important.

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Figure 4: A creative way to illustrate framing and implementation of NBS

3.3.2 Some example of nature-based solutions

For each topic below, participants tried to determine possible NBS but they faced some difficulty in providing concrete, detailed examples. This shows that the concept still need some maturation. Additional events and consultations would therefore be very valuable.

3.3.2.1. Disaster risk management/prevention

Participants highlighted the need for NBS for risk mitigation and prevention, e.g. to reduce the intensity or extension of fires, or the economic and human impacts of land slides or floods.

A specific example of NBS: ***Traditional sylviculture and extensive prairie and field management (now included in such management packages as agro-ecology or adaptive forestry) to prevent or mitigate disasters***.

A particular attention should be given to the risks of some NBS to become a "disaster" themselves after a certain period of time. Eg : myxomatosis and related viruses introduced in Australia to manage invasive rabbits[16] have become a problem itself

3.3.2.2. Climate change mitigation and adaptation to climate change

Participants highlighted several potential areas for NBS that can be broadly summarized under two headings:

- **NBS for reducing carbon emissions:**
    - ***NBS could focus on innovative approaches for conserving and restoring peatlands***
      Degraded peat land and peat land converted to agricultural land contribute significantly to global carbon emissions. Restoring peat lands can at least help reduce ongoing carbon emissions, although a recent systematic review has shown that restored peat lands also emit high levels of CH4. It seems very difficult and, if at all possible, it will take decades for restored peat land to regain its original capacity of carbon fixation. It should therefore be a first priority to halt all further destruction of functioning peat land, while exploring innovative ways to restore the degraded peatlands.

[16] http://www.liberation.fr/sciences/1996/01/16/hecatombe-de-lapins-australiens-plus-de-dix-millions-sont-deja-morts-histoire-d-une-bavure-scientifi_160045

- ***NBS to adapt/change the management of some production systems***
  e.g. rice production systems to decrease CH4 while fulfilling farmers income and food supply, or other agricultural production systems (particularly meat production, see below climate smart 'food production and consumption').

- ***Identifying NBS to mitigate or stop ocean acidification*** These could contribute substantially to restoring the marine system, which plays an enormous role within the global carbon cycle.

- **NBS for increasing ecosystem resilience**

Practically all ecosystems are affected by climate change and their resilience to changes and shocks as well as their capacity to deliver ecosystem services are often reduced. Therefore, increasing ecosystem (including agroecosystem) resilience should be considered as a major facet for many NBS. The above-mentioned conservation of natural sinks and buffers (e.g. peatlands and oceans) can contribute to this as well. Thus, both strategies (mitigating carbon emissions and increasing ecosystem resilience) are mutually re-enforcing.

- **Managing an increased diversity of tree genotypes to improve forest resilience to climate change and natural hazards**. With the advancements of genetic identification technologies now available, these technologies can be applied to identify well-adapted cultivars and use them to improve forest species composition in order to make forests more resilient to changing climate conditions. It is also noted that Protected Areas have proven to constitute important genetic reservoirs providing a broad diversity of cultivars.

- ***Ecosystem restoration as a tool to provide considerable social co-benefits*** through increased contact with nature, and by providing green jobs; the latter is often more cost effective than other job creation programmes (see the case of Sweden).

- ***Greening cities*** can contribute to both strategies above and at the same time, provide significant health benefits (e.g., reduced heat, more fresh air, contact with nature improves mental health).

There are significant co-benefits between the conservation and sustainable management of ecosystems and climate change adaptation. In cities, almost all nature-based measures contributing to climate adaptation simultaneously contribute to climate change mitigation as well. So in this context, NBS should be a preferred policy option in both highly transformed ecosystems and in still very natural ones.

The group further discussed the need to adapt management of agricultural production systems and forestry so that they are better adapted to climate change. For agricultural production and consumption in particular, options for reducing greenhouse gas emissions were discussed. These are integrated with the results from the next group below.

3.3.2.3. Food production and consumption/ Food Security

Here, we report the results from several of the discussion groups that approached NBS and food production/food security through various angles:

- **"Climate-smart" Food production and consumption** based on less meat and dairy consumption. NBS should promote more "closed-cycle" production systems to reduce CO2, biodiversity impacts, as well as "externalities" such as N or P Pollution (this would help increase resilience of ecosystems), while ensuring farmers' incomes and sufficient and reliable food supply, and making sure

  A huge potential for improvement could be achieved if consumer habits (especially diets and lifestyle) are changed. There are some positive examples of how more biodiversity-friendly or climate change mitigating habits have been achieved; it would be beneficial to systematically analyse these and learn from them. E.g. publicly known personalities can play important roles as ambassadors. One example cited was of a famous chef who managed to significantly increase *Anchovis* consumption, formally considered a 'poor people food' in Peru. Similarly one could learn from the commercial introduction of new foods/habits. Key questions include: How to attach a positive image to the desired habits? How to reach the mainstream, not only niches of the population?

- **Agro-forestry as a NBS to sustainably produce food and fibers, while improving agro-ecosystem resilience to natural and economic hazards**

- **Alternative food sources (e.g. invertebrates) as a (nature-based) solution to reduce the environmental impact of food production shortage**
  The use of arthropods as a food source appears to be an emerging topic in European cuisine. At present, arthropods for consumption are farmed, The animals could also be harvested from relatively bio-diverse localities. An intriguing idea concerned the use of invasive alien arthropods as a food source, which ideally would tackle two problems at once. Examples of possible solutions: 'the blue cricket' or the 'red-veined darter' approaches.

- **Copying key features of natural high-productive systems as a (nature-based) solution for maintaining soil productivity on the long term**

- **Crop rotation approaches adjusted within the economical & governance framework**

  This technique allows replenishment of nitrogen through the use of green manure in sequence with cereals and other crops. Crop rotation also mitigates the build-up of pathogens and pests that often occurs when one species is continuously cropped, and can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants.

- **Establishment of ecological focus areas**

  These are areas for nature on farms. Such areas provide support for pollinators and beneficial organisms, which in turn, help with natural pest control. Such areas can also improve soil quality and soil fertility, provide erosion control, and contribute to scenic quality and cultural identity. While this issue has already been tackled by research, more integrative and innovative approaches are still needed.

3.3.2.4. Water production

- ***Natural filtration systems and buffer zones*** **as a (nature-based) solution for water pollution.** Examples cited were reed beds on local scale, wetlands on a wider scale.

3.3.2.5. Soil, Forest & Land Management

The major, over-arching issue (problem) identified in this area was the multifunctional use of landscape, more specifically for livestock; crop plants; recreation; wood production etc. leading to multiple stressors. This causes soil sealing, soil degradation, soil pollution; unsustainable food systems; emerging diseases; flora-fauna disturbance – to name a few.

- The main NBS identified was "**Integrated Spatial Planning/Management of the land- and sea-scape mosaic**"

However, participants agreed this was still too vague. Therefore, they decided to focus on the problems of unsustainable food systems (reported above) and emerging diseases.

- **NBS relying on the use of resilient genotypes, increased plant/soil diversity, and biological control agents to tackle emerging diseases such as tree pests** (e.g. Ash dieback (Chalara) and Phytophtera), thus reinforcing the economic and social benefits to key sectors**.**

3.3.3 Knowledge needs/research recommendations related to nature-based solutions:

The research recommendations identified below are not exhaustive but still indicative of some key areas of research that could be addressed to support the identification and implementation of nature-based solutions.

3.3.3.1 General research recommendations on Nature-based solutions

In relation to the concept of nature-based solutions, research is needed to:

- Systematically assess the trio of economic, social and environmental benefits/ indicators for human well-being while addressing timescale for delivery of benefits
- Develop cost-effectiveness assessment and financial implications of NBS: This will require focusing on the valuation of some particular elements of ecosystem assessment that are not yet well investigated
- Explore political and social resistance to change what would be needed for implementing some NBS
- Further understand the drivers, correlates and incentives that drive the clash between the socio-economic and the natural environments and that could block a proposed NBS.
- Develop transdisciplinary methods and explore participatory ways of translating and sharing lessons learned on NBS (communication and collaboration with stakeholders)
- Develop risk assessments of NBS, especially for ecological risks
- Conduct research on the governance needed to address the results of NBS risk assessments
- Further understand the ecological processes and relationships between biodiversity/ecosystem functions and ecosystem services to feed potential NBS. There is a need for an understanding of these functions and services but also on how to restore or improve them.

A major enabling action would be to:

- Create a European Training Network for building the interdisciplinary and transdisciplinary capacity on NBS.

3.3.3.2 Some specific research recommendations related to previously identified examples of nature-based solutions

Here we report some research needs linked to the NBS examples identified during the discussion sessions and listed in the previous section. This is not a

complete or exhaustive list of research priorities for each of the mentioned topic, but it is meant as a trigger to stimulate further discussion on NBS.

- **Climate adaptation and mitigation**

  - **Reducing carbon emissions**

    NBS-relevant research on peat land conservation and restoration: Research needs arise with regard to optimal restoration approaches and better understanding of 'if' and 'how' peat land can regain its capacity to mitigate climate change (carbon sequestration and reduction of greenhouse gases) while providing social and economic benefits and preserving biodiversity..

    Research on NBS options to stop or largely mitigate ocean acidification: There are significant knowledge gaps and research needs related to both the natural science involved and the most promising policies to successfully reduce ocean acidification in practise; this may include geo-bio-engineering approaches that would fulfil the NBS concept

  - **Increasing ecosystem resilience**

    One general research need is to ***increase the understanding of the role of Biodiversity for ecosystem resilience*** *as a basis of many NBS*

  - **Greening cities**

    Some remaining research gaps include: What are ***specific contribution of different species, potential and challenges of introducing species, creating new ecosystems***? as greening cities often rely on newly created ecosystems.

- **Sustainable food production and consumption/ Food Security**

  - ***"Research to support Climate- and biodiversity- smart" Food production and consumption*** based on less meat and dairy consumption.

The identified research gaps focussed mainly on socio-economics and policy including questions such as: how can a more "politically viable" reform of Common Agricultural Policy (for the EU, but also globally) be derived?

Specific aspects include: How to achieve more climate and biodiversity benefits through subsidy reforms and other instruments? E.g. taxes

  - ***Research on Alternative food sources (e.g. invertebrates)***

There are some knowledge needs related to alternative food sources (e.g. invertebrates) as a (nature-based) solution to reduce the environmental impact of food production:

- Feasibility within and across Europe, both climatically, ecologically and socio-economically of these alternative food sources
- Consumers acceptance is an overruling factor as there is a reluctance to this kind of food, yet many details of this might represent knowledge gaps worthy of further investigation.
- Harvesting techniques & impacts on local biodiversity and ecosystem functioning

- ***Research on copying natural high-productive and resilient systems as a (nature-based) solution for maintaining soil productivity***

Many potential knowledge gaps on natural high-productive systems are related to the domains of soil ecology and biogeochemistry. These are currently very active fields of research, so progress towards nature-based solutions for these issues should be ongoing. In particular, the capacity to manage and even manipulate soil biodiversity to better deliver a range of services and increase ecosystem resistance and resilience to natural hazards still remains a challenge

There might be much to learn from old (forgotten?) agricultural practices. Research into such practices might equally be recommended.

- ***Research to make our food supply/systems sustainable***

In this area, further research would be needed on effectiveness of 'green elements' in enhancing agricultural productivity, pathways used, multi-functionality and long-term sustainability

- **Water production**

  - ***Research on natural filtration systems and buffer zones (reed beds on local scale, wetlands on a wider scale)* as a NBS for water pollution**

The possibility to develop and manage reed beds and wetlands to filter out major nutrients like nitrogen and phosphorus has already been extensively addressed. However, this remains to be addressed for several substances (e.g. **pharmaceuticals),** accounting for effects on ecosystem / species and human health. Where nature-based solutions and especially engineered new ecosystems

would be implemented ('NBS sites'), the possibility to favor invasive alien species should be carefully evaluated.

- **Soil/forest/land management**

    - ***Research is needed to further explore integrated spatial planning and management of the landscape mosaic.*** *Among other issues, it will be needed to assess if Green Infrastructures are fit for purpose, e.g. through comparative assessments of current methodologies (especially for population genetics and functional connectivity)*

    - ***Research is needed to improve the understanding of resilience of ecosystems (mechanisms/pathways/importance of keystone species…)*** *as a basis for many NBS;* this includes better knowledge of the role of functional and genetic diversity; and a better understanding of community dynamics in anthropogenically modified landscapes.

    - ***Research is needed to manage landscape to deliver multiple services, including more efficient control of pests:*** this requires to account for long term dynamics of resilient genotypes, effects of increasing plant/soil diversity, and effects of biological control agents.

4 Conclusions

This workshop was a good opportunity to see how experts from various disciplines (although the audience was mainly dominated by natural sciences, it also includes social scientists) tackle the new concept of nature-based solutions. Clearly the first round of discussions and the analysis of expectations and concerns showed that the concept raised a lot of questions and that participants felt uneasy to quickly jump into identifying examples of nature-based solutions. Some discussions on the framing of the concept and conditions of implementation were necessary and these generated important recommendations. In particular, many participants recognized that NBS can contribute to help develop more sustainable practices in many fields, but highlighted that there will be few 100% win-win situations (i.e. where environmental, social and economic benefits are simultaneously met). Trade-offs will thus have to be systematically explored and characterised to help decision making. They also pointed to the need to change management and governance of socio-ecological systems and to accept complexity, uncertainty and diversity.
An important contribution was the development of a typology of NBS (see Figures above) :

1- NBS Type 1: They consist in better using existing natural or weakly managed ecosystems; the ambition here is to better use them, delivering a

range of ecosystem services in and outside these ecosystems while minimising the intervention on the systems themselves.

2- NBS Type 2: They correspond to the definition of management rules to develop sustainable and multifunctional ecosystems (possibly intensively managed) and better deliver selected ecosystem services.
3- NBS Type 3: They consist in managing ecosystems in very intrusive ways or even creating completely new ecosystems.

Another key comment related to the links between all the concepts and terms that are currently used: ecosystem based adaptation, ecosystem approaches, green and blue infrastructures, sustainable development, natural capital, etc. There is a call for clarifying how all these terms connect as they seem to serve a common goal and partly overlap.

Some of the (research) recommendations relate to general criteria/framing conditions of NBS, such as the need to explore risk assessments, and the importance of developing transdisciplinary approaches with a good engagement of stakeholders throughout the whole research process.

Some specific knowledge gaps were also identified in relation to the proposed NBS examples. However, it appears that developing research needs for NBS is sometimes difficult, since this requires to develop a very integrative view, accounting not only for the environmental aspects but also the social and economic ones. Further discussion and consultation is needed to investigate in more detail the cases/issues where NBS could bring added value.

Thanks to this workshop, BiodivERsA contributed to the evaluation of the NBS concept, proposing a typology of NBS and providing key recommendations. This will be used to evaluate the way BiodivERsA could take these further in its future activities.

Annex 1- FINAL PROGRAMME

Wednesday 11 JUNE (p.m.)
13.00 – 14.00: Registration

14.00 – 14.15: Welcome (aims of the workshop & practicalities) *(Hilde Eggermont & Estelle Balian, Belspo)*

14.15 – 14.30: Nature-based solutions for Horizon2020 challenges (*Adrian Peres, DG-RTD*)

14.30 – 15.00: Nature-Based solutions from a IUCN perspective

- 14.30 – 14.45: Pioneering nature-based solutions *(Chantal van Ham, IUCN)*
- 14.45 – 15.00: Blue Solutions for marine and coastal biodiversity conservation *(James Hardcastle, IUCN)*[17]

15.00 – 15.15: Nature-based engineering & water services (*Victor Beumer - Deltares*)

15.15 – 15.30: BiodivERsA past and future activities, and link with nature-based solutions (*Xavier Le Roux, BiodivERsA project coordinator*)

15.30 – 15.45: Nature-based solutions in an urban context: how smart are smart cities? (*Thomas Elmqvist, Stockholm Resilience Center, URBES project)*

15.45 – 16.15: Panel discussion on the added value of the Nature-Based solution concept; challenges; concerns…

16.15-16.40: COFFEE BREAK

16.40 – 17.15: 5 min presentations by BiodivERsA project scientists illustrating nature-based solutions in their research project

17.15 – 18.00: Round table discussion I: working groups will be organized by thematic such as climate change adaptation, water management, food security etc. During the group discussions participants will identify potential Nature based solutions in their field of research/expertise, and experts from BiodivERsA funded projects will identify connections between their project and Nature based solutions.

Social event: 18:30: Guided walk from Belspo to Musée des Instruments Musiques (MIM), Bruxelles and 19:30 light diner (buffet) in the panoramic restaurant of the MIM.

Wednesday 12 JUNE (a.m.)

9.30 – 9.50: Wrap-up of 1st day; Nature-Based solution (awareness) movie

9.50 – 10.30: Round table discussion II: working groups work continues. Scientists and other participants will also discuss potential research priorities (cf. key knowledge gaps) to better help developing nature-based solutions for these thematics/fields.

[17] The presentation was a narrated powerpoint displayed on the morning of the 12th of June

10.30 – 10.50: COFFEE BREAK

10.50 – 11.30: Round table discussion III: working groups' final session to compile and present discussions results and recommendations.

11.30 – 12.30: Debriefing and Conclusions

Annex 2- Round table discussions- Raw notes

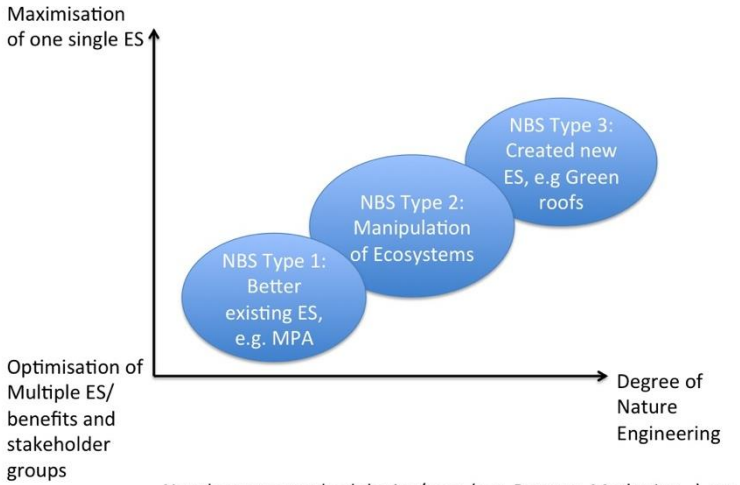
Group 6 Day 2: "Framing the concept of NBS"

General comments on the concept:

- Main questions/aspects to consider
    - It might be a new concept but encompassing already existing things
    - There might be innovative components in "old ways"
    - Importance to look back at what is done to identify the potential NBS
- Not just focus on "the solution" but also the nature-based process that can include improvements
- Important to clearly define the problem: if it is a complex/wicked problem there might need to be a negotiation process and not just simple solutions
- NBS can be looked at through building blocks (e.g. Landscape approaches)
- Importance of sharing existing knowledge on NBS: give both good and bad examples not just in developing countries but also in developed countries.
- Include other knowledge types than just scientific knowledge to look at NBS
- Links with other concepts such as Green Infrastructures: GI can be part of NBS or NBS can be used to build GI
- NBS is a tool to provide input for different policies (through the understanding of social and economic benefits in addition to environmental ones)
- It is important to take in consideration the target audience for NBS: reframing the message for each audience
- NBS should be have a risk assessment to comply with precautionary principle

Proposed typology

1- Better using existing Ecosystems
2- Modifying Ecosystems to better deliver services
3- Creating completely new Ecosystems (i.e. ecological engineering



Not the same methodologies/uses (e.g. Patents, Marketing…) can be applied for the NBS of type 1, 2 and 3
Type 2 might be the more challenging

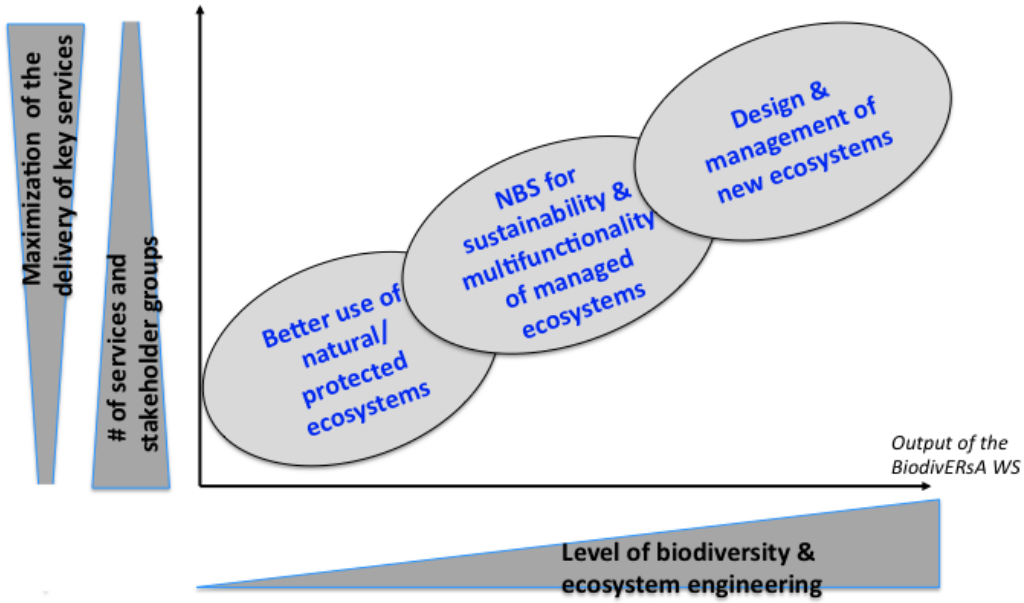


Figure 1 : Schematic representation of the range of NBS approaches to be considered. Three main types of NBS are defined, differing in the level of engineering applied to biodiversity / ecosystems (X axis), and in the number of services to be delivered, the number of stakeholder groups targeted, and the likely level of maximization of the delivery of targeted services (Y axis).

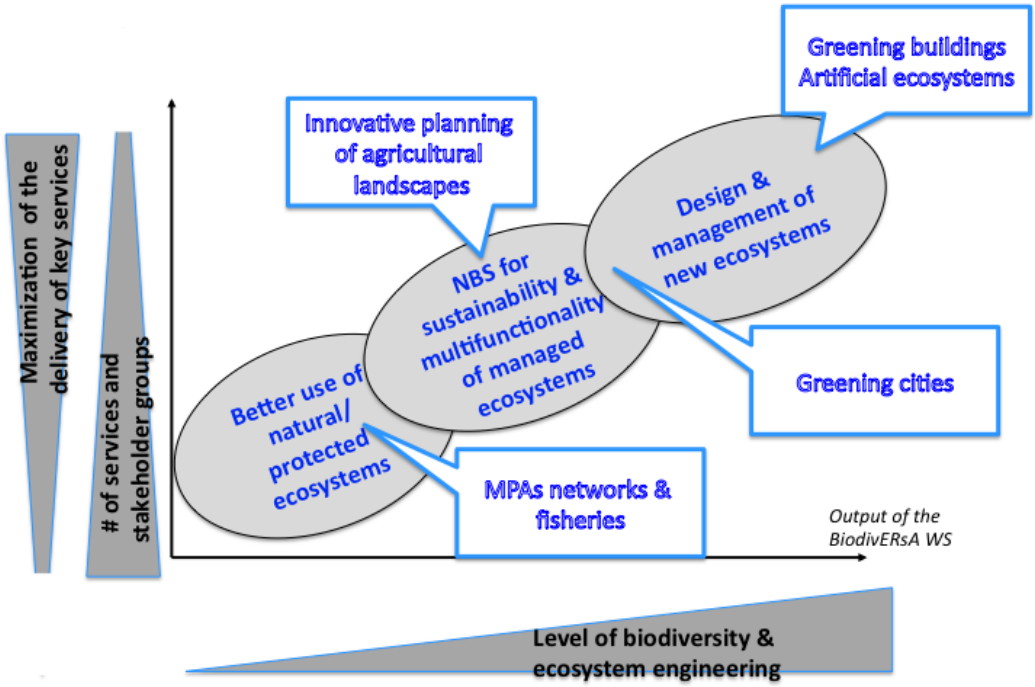


Figure 2 : Some examples of NBS located in the schematic representation of Figure 1.

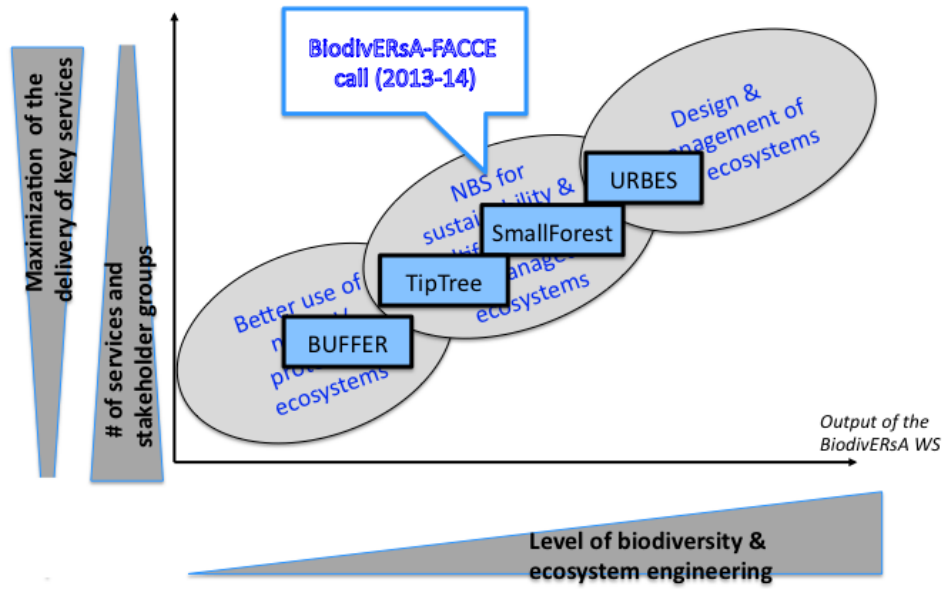


Figure 3 : Some examples of NBS-relevant research projects funded by BiodivERsA located in the schematic representation of Figure 1. The type of NBS addressed by the BiodivERsA-FACCE call launched in late 2013 is also indicated.

Knowledge needs regarding NBS :

- How do we assess the trio of benefits/ Indicators for well-being reconciling Economic, Social and Environmental, and Timescale for delivery of benefits
- How do we assess if Green Infrastrucutures and fit for purpose/ comparative assessments of the methodologies especially for population genetics and functional connectivity
- Risk assessments of NBS especially for ecological risk
- Cost-Effectiveness assessement: Valuation of some particular elements of ES
- Explore Political and social resistance to change that would be needed for some NBS
- Explore participatory ways of translating and sharing lessons learned on NBS
- Research on the governance needed to address the results of the risk assessment
- Still maintain research on the relationships between biodiversity/Ecosystem functions and Ecosystem Services to feed potential NBS
- Create a European Training Network for building the interdisciplinary and transdisciplinary capacity on NBS

Group 1 Day 1 &2: "Climate Change adaptation and mitigation"

- Reduce Carbon Emission
  1. Peatland conservation and restoration (less effective)
     a. Analyse full set of impacts (carbon, BD, Well being) of any solution
     b. E.g. Water management
     c. How to reduce N Pollution
  2. Eat less meat and dairy
     a. how to turn it into something positive : use ambassadors ??

- Adapt/change management of e.g. rice production decreases CH4
- Marine Restoration: what are the last options to stop acidification
- Increase Resilience
  - Water management
  - Conservation
  - Restoration
    - Social co-benefits from increased contact with nature
    - Green jobs
  - Using genetic reservoirs from PA to improve forest ? species composition
    - Better understand the role of BD for resilience
  - Greening cities
    - Health benefits (heat, air, contact with nature improves mental health)
    - What are specific contribution of different species

Develop politically ??water policy ?? more for ???
Develop closed-cycle agriculture

Power of biodiversity for CC mitigation and adaptation

- Conserve natural sinks and buffers (e.g. Peatlands, ???) but also other natural systems (e.g. Protected Areas as genetic reservoirs)
- Restore degraded Ecosystems, watershed management, Green cities

➢ Benefits : health benefits, social benefits e.g. jobs, ??? to nature, biodiversity habitat

- Which species are best suited ?
  - Potential and challenges of introducing species
- Which policies are most promising, e.g. to reduce ocean acidification ?
- Best approach for « in between » (very valuable-degraded) landscapes ?

Climate proof solutions

Analyse full set of impacts (CC, Biodiversity, Social well being) of all solutions but also current lines of production to avoid « wrong » solutions e.g. Biofuels

➢ Risk assessment
➢ Life cycle analysis
➢ Precautionary principle

- How to ensure it is adequately included in policy?
- Trade offs fully covered

Legend:
Research gaps-knowledge gaps
NBS, approach measure
Co-benefits

"Climate-smart" Food production and consumption

- More closed cycle production systems
- Reduce CO2, biodiversity impacts, "externalities" such as N Pollution, P, etc.
    - Helps increase resilience of Ecosystems

- Politically viable "CAP" reform
    - How to achieve more climate+biodiversity benefits in sbsidy reforms? + other instruments e.g. Taxes
- Change consumer habits especially diets and lifestyle
    - Learn from positive examples, e.g. ambassadors, chefs, "Anchovis in Peru"
    - Also commercial introduction of new foods/habits
    - How to make it something positive
    - Reach the mainstream, not only niches

NB: similar for energy production and consumption

Group 2 Day 1 & 2: "Water and food production"

Day 1

No participant claimed to be an expert in the fields of food production and water (the latter being defined as freshwater quality and availability), nor to work on a related BiodivERsA project. Therefore, participants seemed to approach this round table discussion rather as a brainstorm exercise. On this first day, the participants identified the following challenges (issues), and corresponding nature-based solutions.

Main challenge / issue	Nature-based solution
1. Sustainable food production	Agroforestry
2. Reduce the environmental impact of food production	Alternative food sources (e.g. invertebrates)
3. Maintain soil productivity	Copy natural high-productive systems
4. Pollution	Natural filtration systems and buffer zones (reed beds on local scale, wetlands on a wider scale)

While doing this exercise, it appeared unavoidable for some participants to also have a discussion on the meaning (definition) and added value of the nature-based solutions concept itself. Since this was not central to the round table discussion, these outcomes are not reported here.

Day 2

The group of participants on day 2 largely consisted of the same people as that from day 1. We therefore chose to stick to the nature-based solutions already identified and hold an in-depth discussion on them (table above).

1. *Agroforestry* as a (nature-based) way of sustainable food production

The one participant that suggested this solution was not present. As the other participants were not acquainted with this discipline, no one felt comfortable to further discuss agroforestry.

2. *Alternative food sources (e.g. invertebrates)* as a (nature-based) solution to reduce the environmental impact of food production

An extensive and animated brainstorm discussion developed on the ecological aspects of "eating bugs" (as one participant put it simply). Indeed, the use of arthropods as a food source appears to be an emerging topic in European cuisine.
At present, arthropods for consumption are farmed, so this would hardly classify as a nature-based solution. For it to be nature-based, the animals should be harvested from relatively biodiverse localities instead. Clearly, there are some related issues for which knowledge is lacking, and further research would be needed:

- the feasibility within and across Europe, both climatically, ecologically and socio-economically
- harvesting effects on local biodiversity and ecosystem functioning
- harvesting techniques
-

All participants agreed that consumer acceptance is an overruling factor, here. Overall, there seems to be a reluctancy to this kind of food, yet many details of this might represent knowledge gaps worthy of further investigation.
An intriguing idea raised by one participant (an expert on invasive alien species) concerned the use of invasive alien arthropods as a food source, which ideally would

tackle two problems at once. This proved an interesting topic for further discussion. For instance, it inspired one other participant to put larvae of an invasive dragonfly species (a darter species) on the menu in Sweden.
This proved a fun part of the discussion. Solutions were nick-named 'the blue cricket' and 'red darter approach', and little drawings of them were made on the flipchart...

3. *Copying natural high-productive systems* as a (nature-based) solution for maintaining soil productivity

Any potential knowledge gaps on natural high-productive systems were perceived as falling within the domains of soil ecology and biogeochemistry. These are currently very active fields of research, so progress towards nature-based solutions for these issues seem to getting covered.
In contrast to the cutting-edge advances in these fields, it was raised by several participants that there might be much to learn from old (forgotten?) agricultural practices, here. Research into such practices might equally be recommended.

4. *Natural filtration systems and buffer zones (reed beds on local scale, wetlands on a wider scale)* as a (nature-based) solution for water pollution

The role of reed beds and wetlands in filtering out major nutrients like nitrogen and phosphorus has already been extensively studied, the participants agree. However, for several substances (e.g. pharmaceuticals), we need more on bio-accumulation/cycling... and its effects on ecosystem and species health.
One participant raised the question whether sites where nature-based solutions would become realized ('NBS sites'), would not particularly favor invasive alien species, given their degree of suboptimal habitat quality and anthropogenic disturbance.

5. *General*

The discussions were mostly restricted to the very specific suggestions of solutions identified on day 1, and no general research needs were identified. Yet, the research needs listed could inspire specific BiodivERsA projects on the challenges listed in the table. Also, this proved a valuable opportunity for the participants to reflect on the conceptual bases of nature-based solutions, and how to turn these into practice.

Group 3 Day 1 & 2: "Soil, forest and land management"

During the discussions, some general (concept-related) issues were mentioned:

- NBSolutions are case specific; you cannot easily transfer them to other settings
- Before implementing NBS, a sound risk assessment is needed (likely also a Plan B)
- NBS need to account for future environmental changes
- NBS should account for multiple interest (economic, environmental, societal,….)
- Problem/Issues as defined during this workshop are still far too general. We need to specify/detail (i.e. various sub-issues to deal with)…
- A NBS solution can – at some point – become a problem (cf. pest control>invasive species)
- One cannot ignore Local Knowledge in identifying NBS
- A NBS for one particular problem, could also be a potential NBS for another problem

The major, over-arching issue (problem) identified in the area of "Soil, Forest & Land management" during both discussion days was the "Multifunctionality of landscapes (livestock; crop plants; ..)/multifunctional use leading to multiple stressors".

A major NBS identied was "Integrated Spatial Planning/Management of the landscape mosaic" though participants agreed this was still too vague.
Sub-issues identified under this umbrella included:

- Sustainable food supply
- Soil sealing, soil degradation, soil pollution
- Emerging diseases
- Recreational issues leading to soil compaction/flora-fauna disturbance
- Forest logging
- …

On day two – participants mainly focused on the issues of "Sustainable Food Supply" and "Emerging diseases/Pests".

Sustainable Food Supply
Several aspects were considered important to ensure this:

- Flood defence
- CO2 storage
- Improved water quality
- Nitrogen uptake/release
- Animal welfare

Possible NBS solutions identified included:

- Crop rotation (but it will need adjustment within the economical & governance framework)
- Riparian buffer zones
- Ecological focus areas (contributing to pollinator diversity etc.)

Research needs identified in this area

- Studies on agricultural production systems

Emerging diseases/pests
Most importantly:

- Tree pests
- Ash dieback (Chalara)
- Phytophtera

Possible NBS solutions identified included:

- Resilient genotypes
- Plant/Soil diversity
- Biological control agents

Research needs identified in this area

- Understanding the resilience of ecosystems (mechanisms/pathways/..)
- More research is needed in the field of functional and genetic diversity; need for a better understanding of community dynamics/interactions between species/…

Group 4 Day 1 & 2: "Disaster risk management"

Day 1.
From the experience of the members of the group, the examples of disasters for which a NBS could be developed centered around issues that turned out to be related to land cover, including

- Land slides
- Fires
- Soil erosion
- Floods
- Invasive species
- Climate change

Several disaster examples came from the participants experience in Forest management, which is a topic where many of the above-mentioned disasters are occurring. However, they could not identify and provide concrete examples of NBS's applied to risk management in any of these areas (beyond the perception that these problems were caused by human changes to land cover), neither provide a link to any concrete BiodivERsA project.

The participants nevertheless concluded that NBS should be better applied to risk mitigation and prevention, e.g. by reducing the intensity or extension of fires, or the economic and human impacts of land slides or floods. They identified the need for involving the different stakeholders from the very beginning of the NBS process, in particular for the following steps:

- ✓ Identification of the problem
- ✓ Identification of the natural processes occurring
- ✓ Knowledge building, information gathering.

A particular attention was drawn on the potentiality of some NBS to become a disaster after a certain period of time. Eg : myxomatosis and related viruses introduced in Australia to manage invasive rabbits.
NBS such as traditional sylviculture and extensive prairie and field management (now included in such management packages as agro-ecology or adaptive forestry) apply to prevent or mitigate disasters.

A large part of the NBS solutions should be based on the integration of **systems diversity** (see Thomas Elqmvist's presentation) at any integration level of the biodiversity. E.g: a forest which is diverse from a genetic point of view, age structure, community composition as well as ecosystem and landscape involved, will definitely be more prone to resist to disasters.

Day 2

Due to a shift in participant's contribution, the subsequent discussion focused more on disaster prevention.

Participants reasoned about knowledge gaps on a very general basis, and came up with two main ideas.

1. If a NBS is to be implemented, research may be needed on the natural side of it. Participants realized that there is a chain that starts with species which are involved in ecological processes and that these in turn provide services.

   For some participants, these services are the core of the NBS, and restoring or improving them should drive the research, while for other participants, the ecological processes are the core of the NBS. The research itself should therefore be focused on unraveling the **underlying ecological processes**, and go down at the species level only when needed to elucidate a particular issue.

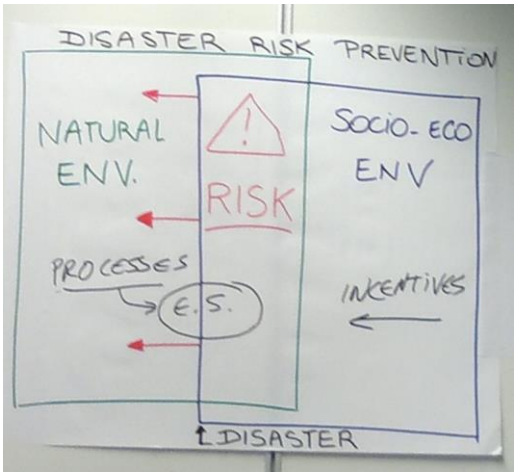
   An outcome of this is that disaster risk reduction could in these cases be a justification for ecological restoration projects. As personal afterthought, one participant added that there also may be a need for research on how to go about restoring lost or damaged ecological process. This could entail ecology and engineering collaboration. So there is a need for an understanding of the natural processes but also on how to go about and restore or improve them.

2. Considering that disasters, including those listed above, arise in a certain socio-economic context and sometimes spring from human changes to the natural environment, it was also figured that research is needed on the **social and economic drivers or correlates of those changes**. This is particularly necessary because those drivers/correlates may also block any proposed NBS if not considered in the solution.

A particular concern was that NBS are more durable than technological fixes, but that they may take more time to implement. This is particularly obvious if the plan is to restore a forest, in which case the timeframe to completion is measured in decades. In that case, any NBS should include changes in time expectations from the society.

Multi/transdisciplinarity should be a NBS rule (see also stakeholders involvement from Day 1 discussions)

The figure on below was the attempt to integrate all this. In any case, the risk notion arises from a socio-economic context.
Without such a context, there would only be the occurrence probability of a particular event (species invasion, fire event, flooding event, etc.) Risks are seen as increasing with /arising from the socio-economic environment encroaching (red arrows) on the natural environment, affecting the ecosystem services (E.S.) it provides through disruption of natural processes. The two areas of research needed are noted on the figure: (1) on the **ecological processes** that allow the provision of the necessary ecological services, and (2) on the **drivers, correlates and incentives**, that drive the clash between the socio-economic and the natural environments and that could block a proposed NBS.


DISASTER RISK PREVENTION
NATURAL ENV.
SOCIO-ECO ENV
RISK
PROCESSES
E.S.
INCENTIVES
DISASTER

Group 5 Day 1 & 2: "Social and economic innovation"

Table : Brainstorming results on which possible Nature-Based solutions for which issues:

Main challenge/issue	**Nature-based solution/Example from Biodiversa project**	**Knowledge gaps/research needs**
Job creation	Disaster risk reduction based on NBS, e.g. planting trees in watershed; investment in the insurance value of ecosystems – labor intensive	
Lack of bottom-up processes in environmental issues within the EU. How to foster mechanisms for co-production of knowledge? How to scale up?	Social- ecological restoration of degraded areas; creating pockets of social-ecological innovation – linking in a multilevel context	Transdisciplinary processes
Attitude … Poverty	Time frame is important …	
Promote community cohesion Food security Conserving biodiversity	Promote traditional agricultural knowledge	How to increase the economic returns of traditional agriculture How to promote agro-eco-tourism
Out breaking rodents causing damage, leading to culture of use of poison/wildlife damage	Increasing raptor density with nesting patches in otherwise industrial farmlands	Quantify impact on crop rodent population and farmer feeling they are empowered
Poverty Social interaction gaps	Public gardens in cities and towns	

The group discussed several main issues (underlined) and identified within it obstacles and knowledge gaps.

- ***From nature based solutions to nature based process***

Specific solutions follow from the social process needed to discuss and organize solutions. The quality of the solutions thus is considered to be dependent on the quality of the social process, e.g. regarding involvement and support of a diversity stake- and knowledge holders. As such changing mind sets towards environment friendly and sustainable solutions is considered most promising. The solutions and strategies are developed in the social process and may change along the way.
Awareness raising and capacity building is time consuming, but time is short, problem solving is urgent. A collaborative and structured approach is needed that finds a pragmatic balance between broad involvement and the coordination (time) costs for organizing such process. If stakeholders and policy representatives only get together

when the problem has already manifested itself, setting up such process may take too much time in order to address the problem adequately. A pro-active approach would build such collaborative and structured capacity before the problems occur in order to be able to address upcoming problems timely and well prepared.

Knowledge gaps:

- communication and collaboration between different stakeholders; how to make transdisciplinarity really work?

- ***Reconnecting to and through nature, enhancing social cohesion***

Here the example of people jointly planting trees, e.g. in disaster areas, was mentioned as a good example of enhancing social cohesion and helping people to deal with their grief and help them refocus on forward looking instead of stay mourning about the disaster that struck them. Also rebuilding nature may offer jobs to a lot of unemployed people.

- ***Integrated valuation***

When NBP and NBS are only valued in the short term and based only on monetary valuation systems, they have difficulty to compete with more technological grey solutions. When a longer time frame is taken into account as well as also other valuation systems and methods, such as public health, a different assessment can be made, showing the importance of nature based benefits.

Knowledge gaps:

- financial impact of NBS, integrated valuation method is needed (ESS plus other valuation systems and methods)

- ***Time pressure – technological vs natural solutions***

The time frame of nature based solution is key as they might be cheaper but may take more time.
Who decides on the time pressure?
How can we free us from the time pressure?
Are we ready to accept the standards of natural based solutions (Nature decides on time frame)?
Efficiency of technological vs natural solutions: definition of technical solutions: NBS include nature friendly technology

- ***Up-scalability of local solutions***

Looking for actions that can be done on a large scale and in a sustainable way.
What is more efficient: several local projects or few global?
Communication: speak the language of the community 'Think globally act locally"

- ***Changing the mindset how society evolves***

It is important to implement the NBS in effectively (not only to find the solutions, but to implement them). Knowledge gap: how to communicate effectively with a diversity of actors and audiences.

The snail

The body of the snail is made up out of stakeholders, scientists, locals, society and policy makers. They are the driving force to make the snail move.

The antennae are scientists, research organizations, BiodivERsA. They are sensing and giving information to the stakeholders, policy makers etc.

The shell is representing environment, social and economy. The upper curve is the smallest one (environment) but the most original (that's the first part of the snail house growing). Economy is the largest one, a driving force.

The snail moves into a direction. The destination can be many different things and goals.

The time pressure is important, but so is quality of solutions. We need to pace down in order to find better and more sustainable solutions. The pace of the snail also is dependent on the basis on which it moves. It is known that they are slower on manmade roads than in natural surroundings…

Reconnecting to and through nature as important slogan.

Three main knowledge gaps:
Transdiciplinarity (how to organize collaborative bottom up processes), integrated valuation (how to combine diverse valuation systems and methods), communication (how to communicate effectively with a diversity of actors and audiences)

Annex 3- Background reading

- IUCN's brochure 'Pioneering nature's solutions to global challenges: http://cmsdata.iucn.org/downloads/iucn_english_brochure.pdf
- Annex 1 in the IUCN Global Programme specifying the 7 principles of nature-based solutions: https://cmsdata.iucn.org/downloads/iucn_programme_2013_2016.pdf
- Weblinks: http://www.climateactionprogramme.org/climate-case-studies/nature_based_solutions_to_climate_change/ and https://www.iucn.org/what/priorities/nature_based_solutions/
- EC- DG ENV report: Assessment of the potential of ecosystem-based approaches to climate change adaptation and migitation in Europe (Naumann et al. 2011): http://ec.europa.eu/environment/nature/climatechange/pdf/EbA_EBM_CC_FinalReport.pdf
- First Report of the Horizon2020 Advisory Group for Societal Challenges 5: 'Climate Action, Environment, Resource Efficiency and Raw Materials': http://ec.europa.eu/information_society/newsroom/cf/horizon2020/document.cfm?doc_id=539
- An EU strategy on adaptation to climate change: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0216
- Green Infrastructures (GI): Enhancing Europe's natural capital: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC0249
- Genetic variation in wild plants and animals in Sweden (Lundqvist et al. 2007, SEPA): http://www.naturvardsverket.se/Documents/publikationer/620-5786-2.pdf?pid=3390

Annex 4- List of Participants

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