frontiers FOR YOUNG MINDS

BIODIVERSITY
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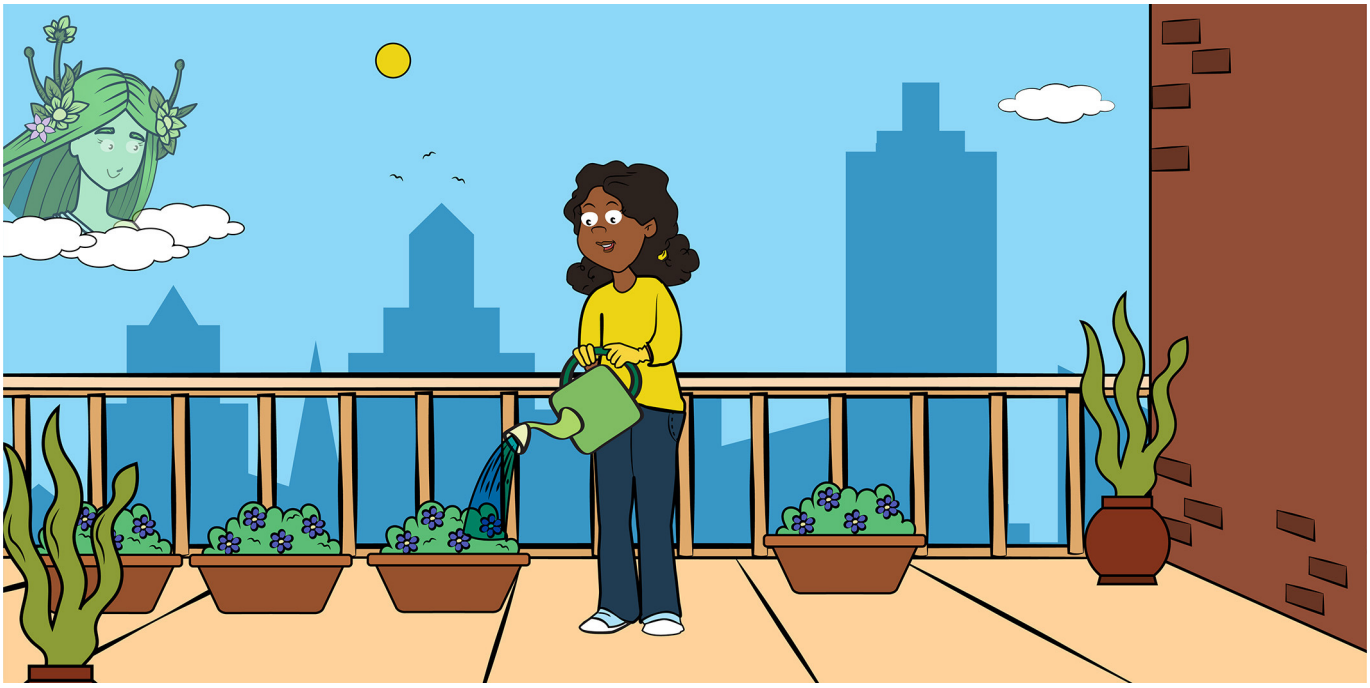

WORKING WITH NATURE TO SOLVE SOCIETAL PROBLEMS

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YOUNG REVIEWERS:

MAGGIE
AGE: 11

MUHAMMAD
AGE: 11

SHREWSBURY SCHOOL
AGES: 13–17

STELLA
AGE: 11

Are you worried about the climate and biodiversity crises and related events like heavy rainfalls and floods, high carbon emissions, sudden heat waves, or loss of species? Are you already doing something to help solve these problems? To reduce flood risks, we can give rivers more space by reconnecting floodplains. To store carbon and help to slow down climate change, we can protect and establish wetlands or mangroves. To make cities cooler in summer, we can plant trees and install rooftop gardens. These efforts to help combat societal problems are known as nature-based solutions. To use nature-based solutions effectively, we need to understand how we can work with nature and the steps we must take to put these ideas into practice. In this article, we introduce you to the concept of nature-based solutions and how they can help solve the climate and biodiversity crises.

THE URGENT PROBLEMS WE FACE

Humans rely on nature for many things. The natural world supports our societies and keeps us fed and healthy. However, over the last few centuries, human use and modification of nature has caused dramatic changes worldwide. Land is being used up for agriculture and housing, coral reefs are being destroyed and lost, and emissions of pollutants and **greenhouse gases** are speeding up climate change [1]. These human-made changes to the earth's natural environment have many frightening effects. Natural disasters, like sudden heat waves, heavy rainfalls, droughts, or storms, are increasing in frequency and severity. These disasters threaten humans and all other species on Earth. Consequently, many plant and animal species have become endangered or extinct, a phenomenon called **biodiversity loss**.

GREENHOUSE GASES

Gases that contribute to rising temperatures on Earth (greenhouse effect), including carbon dioxide, methane, and nitrous oxide.

BIODIVERSITY LOSS

The decline or disappearance of species (e.g., plants, animals, fungi, and micro-organisms), their genetic diversity and/or the habitats in which they live.

If we want to solve these problems, we must turn our fear of these threats into action. That is why young students around the world engage in the Fridays-for-Future-Movement (`https://fridaysforfuture.org`). They are involved in activities to alert other people to the dangers of the environmental damage we are causing. This group seeks to claim their right to a healthy future on Earth. In 2019, they became famous for their "strike for climate" actions each Friday.

The older generations are also involved in solving societal problems. The United Nations, for example, established the Sustainable Development Goals, which are 17 political objectives humans should achieve by 2030. They include taking urgent action to combat climate change and its impacts (Goal 13) and related topics like preserving life below water (Goal 14) and life on land (Goal 15). Each participating country is urged to implement ideas and activities to help reach these goals.

Many of us already do a lot to combat societal problems. Yet, we might be even more successful if we recognize that we do not have to solve these problems alone. Nature itself can help us!

HOW NATURE CAN HELP US SOLVE SOCIETAL PROBLEMS

When you picture a river, what do you see? Perhaps you have an image of water slithering like a snake through the landscape. Maybe you imagine fish in the river, swimming over little stones lining the river's bottom and past dense vegetation along the riverbanks. That sounds like a river in its natural state—that is, one with little or no human influence. However, humans have changed most of the rivers on our planet. Some rivers, for example, are straightened and not allowed to flow freely. Sometimes, walls made of cement or stone are used to line the riverbanks, while dams are used to prevent and control

Figure 1

Figure 1

Nature-based solutions can be used to combat problems in various types of landscapes. **(A)** Protection of a forest on the Danube River near Vienna, (Austria) serves to store carbon and protect biodiversity. **(B)** Green rooftops in Berlin (Germany) help with heat and heavy rainfall, and provide space for people to relax or grow food. **(C)** Vegetation strips on the banks of the River Elbe (Germany) reduce flood risk and improve water quality. **(D)** Reforestation of **mangroves** on the coast in Osa (Costa Rica) protect against flooding and preserve biodiversity, including the fish that are caught for food. Photographs: B. Schröter.

MANGROVES

Trees or shrubs that live in tropical coastal zones, having numerous tangled roots that grow above ground and form dense thickets.

HABITAT

The environment in which a species lives.

NATURE-BASED SOLUTIONS

Actions that use ecological structures and processes for tackling societal problems.

water flow. However, these constructions do not help to protect against flooding more than natural riverbanks do. Therefore, we should give our rivers more space again. Flood plains (land that is naturally flooded when rivers rise) provide **habitat** for many species of animals and plants. When they are not flooded, humans can use flood plains for outdoor activities like running, biking, or just enjoying nature—all of which strengthen our health. Therefore, free-flowing rivers with natural space around them are a solution nature offers for protecting the environment and the society as a whole.

Solutions like this one, which use natural processes to tackle problems such as floods, are called **nature-based solutions** (NBS). In this article, we will focus on the example of rivers, but NBS exist for pretty much every environment (Figure 1). For example, in cities, we can install roof-top gardens where insects and birds can live and where people can relax or grow food. Additionally, green roofs lower temperatures in cities and help to catch rainwater that would otherwise flow directly into the sewage system and, in times of heavy rainfall, possibly cause flooding.

HOW WE CAN WORK WITH NATURE

Let us think about how we could use NBS to help rivers return to a more natural state [2]. Examples of NBS could include removing cement walls or dams, or planting shrubs and trees near the river to help absorb water and decrease the severity of floods. These measures stabilize riverbanks, improve water quality, and provide habitat for the animals that live in or around the river. However, nature-based

Figure 2

Steps used in planning nature-based solutions for societal problems, based upon Albert et al. [3] (Design of original diagram by Metronom, Leipzig, Germany, and icons by `http://handdrawngoods.com`).

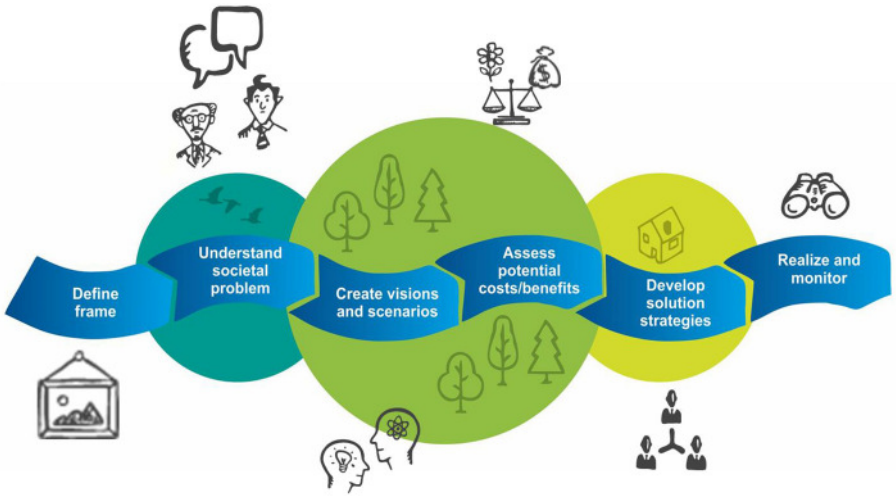

Figure 2

solutions do not happen on their own—they must be planned in a systematic way! The planning of any NBS includes six main steps (Figure 2).

FRAME

The circumstances that determine, specify, or clarify the conditions in a location in which a nature-based solution is to be planned.

First, it is important to define the overall objectives and conditions of the NBS project, called the **frame**. Perhaps our objective is to reduce impacts caused by a river that frequently floods. We need a core team of planners to make decisions about where, when and how to implement the NBS. Which parts of the river would we need to work on? Which season should the work be performed in? Should we remove buildings and farm fields, plant trees, or take some other action? Planners also need to determine how much it should cost and agree on how to organize the work. One essential task for the planning team is to identify all people who could be affected by the project, including both its "fans" and "opponents," and include them in the planning process.

Second, we need to have a clear understanding of the problem that we want to address with the NBS. Societal problems can be viewed from different perspectives. For example, when our river floods, a hydrologist considers the amount of rainfall, an ecologist considers the species affected, and an economist considers the cost of the flooding for the nearby village. A farmer may be worried about his harvest and income, while the mayor may be worried about the houses in her village that are flooded. It is therefore important that all people involved share their different perspectives, to discuss and clarify the problem early in the planning process.

SCENARIO

A description of possible actions or events in the future.

Third, we must create visions and scenarios for how to solve the problem using NBS. Visions are mental pictures of what the landscape would look like with NBS. For our river, our vision might be to give more space to the river for flooding. Visions help us develop various **scenarios**, or different ways that we could achieve the desired vision.

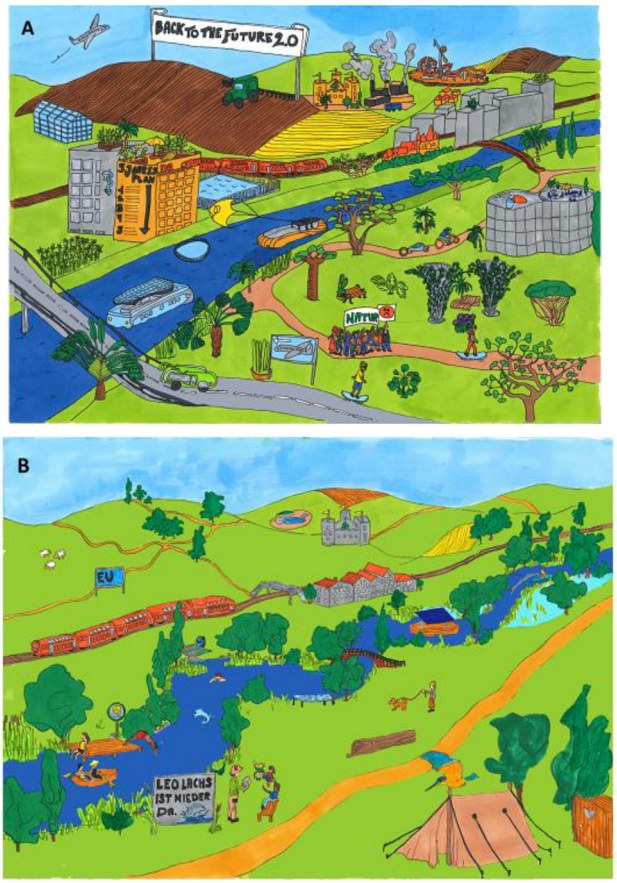

Figure 3

Two scenarios for improving a river landscape to reduce impacts of flooding. **(A)** Scenario with smaller NBS, which involves planting trees and shrubs along riverbanks. **(B)** Scenario with a larger NBS, in which buildings and farm fields are removed to recreate floodplains, to allow space for reforestation and recreation (Image credit: Linda Böhm/mensch und region).

We could come up with a scenario like that shown in Figure 3A, which involves relatively small changes to the landscape, such as planting trees and shrubs along riverbanks. Or we could come up with an alternative scenario that is very nature-focused and includes many changes, including large flood plains and reforestation (Figure 3B). Scenarios help us to identify the advantages and disadvantages of a NBS early on.

Fourth, we need to assess the potential costs and benefits of a NBS in three areas: ecological (how will our scenarios affect the habitats of animals and plants that live in or near the river?), societal (how will our scenarios affect the people that live close to the river), and economic (how will our scenarios affect the income of the people, e.g., of farmers that have farm fields close to the river). The costs and benefits should be calculated in a clear and straightforward way, so that all the people involved in the planning process can easily understand how these factors were determined. The information from this analysis helps the group to choose one of our possible scenarios as a solution.

Fifth, after a solution has been chosen, we must distribute the tasks and define who is responsible for doing what—we need a strategy to make it happen [4]! We need to find someone to pay for the work and

people to do the work. Workers must be hired for tearing down the concrete walls and planting trees, for example.

With a solution in place, we can feel a sense of accomplishment. But wait! We must still monitor the impact. Monitoring includes observation and measurement of a solution's effectiveness. For example, we might monitor the severity of future floods or whether there are more animals or plants living along the riverbanks. Monitoring gives us information that helps us to assess the effectiveness of our NBS and allows us to learn from our successes and failures. This learning process can help future NBS projects to be even more successful [5].

WORKING WITH NATURE REQUIRES A JOINT EFFORT

Nature can support us in solving current climate and societal problems, like biodiversity loss and high greenhouse gas emissions. Scientists and decision makers are beginning to examine and test the roles that nature-based solutions can play to support us in managing and potentially reducing these crises. Hopefully, in the future, NBS will be implemented in our cities, villages, and other areas to improve biodiversity, climate, and ecosystem health, and even human wellbeing. The difficulty lies in the fact that society has many different interests—different humans want different things in their lives and in their environments. However, if they are carefully planned, NBS can serve multiple interests, so that all of us can benefit from them, and nature can thrive. Therefore, to solve our current problems, we humans must all work together—*and* work together with nature!

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ORIGINAL SOURCE ARTICLE

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

MAGGIE, AGE: 11

One day Maggie hopes to be working at NASA designing vehicles to help in the exploration of the outer realms of space. In the meantime, she is content playing basketball, hanging out with her friends, learning more about philosophy, and walking her dog! Maggie loves science and engineering, enjoys enquiring and is

particularly happy when making, building and creating using recycled, everyday objects—the recycle bin is always empty at her house!

MUHAMMAD, AGE: 11

The turning point in my curiosity came when I secured first place in my grade 3 science project. It was about photosynthesis, which I chose after knowing the fact that plants are universal food makers. The science textbook of every grade always familiarized me about the magical wonders behind my daily life's surroundings.

SHREWSBURY SCHOOL, AGES: 13–17

We are the Shrewsbury School *Frontiers for Young Minds* Young Reviewers. Shrewsbury School, Shrewsbury UK has a world-class reputation for all round excellence. We love learning about cutting-edge science and scientific discoveries from a wide range of fields. Our group is made up of students from several year groups who enjoy the challenge and fun that STEM has to offer.

STELLA, AGE: 11

Hi I am Stella and I am 11. I love school and especially English and Drama. Reading is something which I tremendously enjoy and I especially love crime/mystery and realistic fiction. I recently won an academic scholarship and I have really enjoyed the challenges and activities that come with it.

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