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NATURE-BASED SOLUTIONS

FOR CLIMATE CHANGE AND POTENTIAL FOR THEIR IMPLEMENTATION IN SERBIA

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This study was prepared under the "Establishing Transparency Framework for the Republic of Serbia" project (CBIT project), implemented by the Ministry of Environmental Protection with technical support of UNDP and financial support by the Global Environment Facility (GEF) and UNDP's Climate Promise Initiative.

The project is expected to result in an improved system of monitoring, reporting and verification of the data and information for further use in climate and energy legislation of the Government of the Republic of Serbia. The outcomes of the project can also contribute to reporting and obligations which are required by international treaties (UNFCCC and EU commitments). Awareness-raising on climate change and on interventions for combating this challenge is an important project goal, among others.
This study aims to explain the nature-based solutions concept and its implementation framework for proper design of the solution and reduced risk from its misuse; considers the latest literature on the NbS; explores the potential for the NbS implementation in Serbia, by extracting data and information from previous studies and documents and suggests measures that fit the NbS context with potential for implementation in Serbia; advises on actions for enhancing utilization of the NbS in Serbia.

Belgrade, 2021

TABLE OF CONTENTS

ORIGIN OF NATURE-BASED SOLUTIONS

United Nations members adopted in 2015 *The 2030 Agenda for Sustainable Development* (UN, 2015), which defines 17 sustainable development goals (SDGs[1]). To achieve success in implementation of these goals, investments in nature should enable achievement of their potential and ensure long-lasting preservation of well-being of humans and natural environment. One of the goals (SDG13) is to *take urgent action to combat climate change and its impacts*, which would also increase the resilience of other goals vulnerable to climate change impacts.

Governments and businesses recognized the benefits from implementing Nature-based Solutions – NbS (considered as "green" interventions), which can complement direct, engineered ("grey"), interventions and indirect ("soft") interventions (for example, early warning systems), or can be used as an alternative for direct interventions (Seddon et al., 2020). NbS may have been recently defined, but their origins are found in Ecosystem-based Solutions, which is the reason why these terms are usually treated as synonyms. To avoid misuse of nature-based measures and to achieve their full potential with proper implementation, monitoring and adaptability, NbS have been defined and the Standard for their implementation developed.

Members of the International Union for Conservation of Nature (IUCN) adopted in 2016 the resolution entitled Defining Nature-based Solutions (WCC, 2016[2]) which clarifies *the use of nature* for benefits to biodiversity and human well-being. This resolution **defines Nature-based Solutions (NbS)** as follows (Cohen-Shacham et al., 2016[3]):

> *Nature-based solutions are actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.*

1 UN publication *Transforming our World: The 2030 Agenda for Sustainable Development* contains 17 defined Sustainable Development Goals (SDGs) and 169 targets which balance three dimensions of sustainable development (economic, societal, environmental), and are designed as integrated and indivisible. SDGs benefit directly or indirectly from NbS implementation, and with this NbS are considered as important measures providing benefits on all scales – from local to global.

2 The document *WCC-2016-Res-069-EN: Defining Nature-based Solutions* provides Definitional Framework on Nature-based Solutions, including Definition of NbS, Overarching goal of NbS and Preliminary principles of NbS.

3 This publication provides background knowledge for understanding NbS concept, explains the origins of NbS, gives an idea of NbS as an umbrella concept, explains NbS designed for different societal challenges, explains ecosystem-based approaches that belong to the NbS concept, and provide initial guidance for creating an operational framework for NbS.

Diluted meaning of the NbS definition is that NbS are designed as actions (interventions) which: (1) consider the protection of ecosystems, sustainable management of ecosystems and their restoration, (2) should resolve **societal challenges (climate change mitigation and adaptation, disaster risk reduction, economic and societal development, human health, food and water security, environmental degradation and biodiversity loss)**, (3) should be effective and adaptive (adaptability is highly important under the climate change impact or the other dynamical system's changes), (4) should provide benefit to both human well-being and biodiversity, if they are implemented in the right way (this considers protection of nature, including land, and livelihoods as equally important and preservation of their symbiotic functioning as a sustainable pathway for the future). One of the essential requirements for NbS is that natural processes function properly, which is why the monitoring process is important to introduce in NbS context. Because of these ambitious expectations from NbS, instructions for implementation of the designed solutions should be unambiguous, to avoid misuse, and quality performance ensured over long-time scales without harming any component of the human activities and life quality, and of the living environment.

Further development of the NbS concept led to understanding these solutions as an *umbrella concept*, meaning that a broad set of concepts and practices can fit under the NbS umbrella (EEA, 2021[4]), which comprehend interventions and management practices in natural and other infrastructures with the goal of sustainability and probable future self-preservation.

One of the alternative the NbS definitions is given by European Commission: "Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions."[5]. For the purpose of this Study, the IUCN NbS definition is adopted as more comprehensive and more systematically represented, and it is supported by guidance.

To further clarify the use of the NbS context, and to enable users to properly choose and implement NbS – Standard for NbS was developed to provide guidelines for users on how to properly implement NbS and to monitor their progress.

4 Publication published by European Environment Agency "Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction" explains the broadness of the NbS concept primarily in the service of climate change adaptation and disaster risk reduction, provides linkages of NbS with societal challenges and UN SDGs, provides a knowledge base for t NbS- climate change – disaster risk reduction relations, gives an overview of financings of NbS in Europe and practical examples of implemented NbS in Europe (including blue-green corridor case in Belgrade, as A4.7 example). This publication represents an added value for understanding NbS importance in combating climate change and provides a systematic overview of relevant NbS approaches in different sectors.

5 Definition from: **https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en**; it is used in previous publications on NbS in Serbia (Popovicki, 2019; UNDP, 2020). Since IUCN adopted definition describes the NbS actions and goals in a more compressed way, while retaining the broadness of the NbS concept, and is more suitable for further understanding of the NbS Standard (in the following Chapter), it has been selected as the NbS definition for the purpose of this study.

GLOBAL STANDARD FOR NATURE-BASED SOLUTIONS

Scientific research indicates that nature is essential for ensuring human existence and life quality. Conservation of nature was mostly treated as a marginal demand in national and global agendas, but as growing scientific evidence shows strong benefits from the NbS implementation, with lower-costs and sustainable solutions to growing problems, interest to adopt and apply NbS is growing worldwide. A growing demand for NbS, without specific guidelines and definitions, led to the misuse of the NbS concept, which can have a damaging effect on humans and the environment. Good intentions may easily be reverted, due to complex interactions in the climate system, to become damaging to biodiversity and human well-being. Global Standard for NbS was developed to help users properly choose, implement and monitor NbS for identified societal challenges.

IUCN Global Standard for Nature-based Solutions (hereinafter: **NbS Standard**) is a user-friendly framework for verification, design and scaling up of NbS, published in 2020 (IUCN, 2020[6]). NbS Standard was developed to enable users to properly implement NbS, use their full potential, and to monitor their progress. It guides the user to choose and design new NbS with multiple benefits. The use of the proposed framework for NbS is necessary in order to scale up and increase the impact of NbS measures, prevent misuse of proposed NbS measures and to evaluate their effectiveness.

In short, NbS Standard provides guidance for self-assessment to:

- ✓ design new NbS,
- ✓ upscale pilots by identifying gaps,
- ✓ verify past projects and future proposals.

NbS Standard consists of eight criteria and associated indicators. The eight criteria are:

(1) *Identifying societal challenge* to which NbS is a response.

- ✓ Societal challenges are: (a) climate change mitigation and adaptation, (b) disaster risk reduction, (c) economic and societal development, (d) human health, (e) food security, (f) water security, (g) environmental degradation and biodiversity loss.
- ✓ NbS evolves and other specific challenges may be recognized within this scope.
- ✓ One or more societal challenges can be chosen for NbS to address, and the priority is to enhance the utilization of NbS to address multiple challenges (one intervention – multiple benefits).

(2) *Design the NbS* to respond over the full scale of the identified domain where the detected issue (challenge) should be solved.

- ✓ Domain (target area) where the intervention should solve societal challenge is usually part of the larger system (ecological, economic, social).
- ✓ Complexity of the system dynamics must be considered – the intervention may be implemented at chosen site scale, but the response of the whole system should be considered.

(3) *Biodiversity net-gain* is one of the three pillars of sustainable development, and is, therefore, included in this Standard to ensure the NbS sustainability.

6 Publication "Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS" provided by IUCN (2020) is planned to be made available in Serbian language. This guideline is recommended to be adopted as an initial framework in utilization of the NbS in practice, considering all given recommendations and necessary components for successful implementation of NbS.

- ✓ Identified NbS should be environmentally sustainable and with this able to solve identified societal challenge(s) in a long term.
- ✓ NbS strongly depends on ecosystem services and should, therefore, stimulate ecosystem functionality increase.

(4) *Economic feasibility* is one of the three pillars of sustainable development and is, therefore, included in this Standard to ensure the NbS sustainability.

- ✓ Identified NbS should be economically viable and, with this, attractive as the best choice measure for overcoming societal challenge(s), and should prosper as a long-term solution.
- ✓ Return on investment for the implementation of the NbS is requested – long-term gain should be balanced with short-term costs.

(5) *Inclusive governance* is one of the three pillars of sustainable development and is, therefore, included in this Standard to ensure the NbS sustainability.

- ✓ Societal challenge solution should be socially equitable, including involvement of evidence-based solutions and protection of human rights.
- ✓ Good governance, which includes involvement of research, citizens and other beneficiaries' interests, reduces the NbS sustainability risks.

(6) *Balance trade-offs* which have to produce short-term and long-term success of the implemented solution for the societal challenge(s).

- ✓ Compromise should be made in decision making to implement solutions relatively quickly and keep them sustainable, while benefits (gains) are usually required to be achieved in a short time but also kept in the future.
- ✓ Trade-offs in land and natural resource management should be balanced to achieve and maintain ecosystem stabilization but also to comprehend local needs and livelihoods.
- ✓ Trade-offs should be determined in a transparent, equitable and inclusive process.

(7) *Adaptive management* should ensure the evolution of NbS in an adaptive way to respond with gain in constantly changing systems.

- ✓ Continuous learning about system changes and their response to implemented NbS is required – regular monitoring and evaluation are required, including scientific understanding.
- ✓ In case of need, adaptive management of NbS would prevent potentially unintended, unpredicted and harming consequences – harness the ecosystem resilience.
- ✓ Adaptive management minimizes the risks and contributes to the NbS sustainability as part of the complex changing systems.

(8) *Mainstreaming & Sustainability* would ensure adoption of NbS as long-term solutions, in which case NbS full potential can be realized.

- ✓ Inclusion of the NbS concept and related actions into policy, regulatory frameworks strategic documents, international commitments, can ensure the success of the NbS defined, designed, implemented and monitored according to the guidelines of this Standard.
- ✓ NbS interventions should be aligned with sectoral, national and other plans and policies.

In NbS Standard, a set of indicators is listed for each criterion, which enables the user to unambiguously define NbS for targeted societal challenge(s), to identify the scale of intervention and impact, to ensure solution sustainability, to create an adaptive solution and to ensure long-term gain by mainstreaming of solution in the policy frameworks.

If beneficiaries follow this NbS Standard for NbS definition and implementation, it can be assumed that NbS will be firmly established with a prosperous impact on the societal challenge(s), with no harness to the environment nor livelihoods, with ability to evolve and adapt in case of need.

Full guidance for NbS is provided in NbS Standard and it is recommended to adopt this Standard and to work according to its recommendations.

NATURE-BASED SOLUTIONS AND CLIMATE CHANGE

Anthropogenic damaging impact on the climate system[7] by emitting GHG has risen to the scales it may be considered comparable to other natural disasters (Steffen et al., 2015[8]). Disturbances caused to the natural system bounce back to harm livelihoods. While human technologies, with their cumulative effect (increase of GHG in the atmosphere), can cause a planetary-scale disturbance to the system, they are still not developed to have the ability to stabilize the large systems. For this purpose, it is recognized that natural processes, if triggered in the right way, can stabilize the large nature systems. This means that the implementation of NbS may have potential to solve challenges and to fullfill high demands for continuous gain over the larger spatial and temporal scales (stabilizing large systems) and may have a multiple purpose in solving different challenges. Various societal challenges identified under the SDGs can benefit from the implementation of one NbS or a cluster of NbS in terms of climate change adaptation and disaster risk reduction (EEA, 2021[9]).

Climate change is one of the societal challenges identified for the application of NbS. Because of the impact of climate change on the climate system components and their interactions, the implementation of NbS that are designed for climate change challenge can increase the resilience of other societal challenges. Exploring benefits to more than one societal challenge by implementing NbS, rather than choosing many NbS for a single societal challenge is advised in NbS Standard. This is important for designing and prioritizing NbS measures.

Climate change solutions in general target climate change mitigation (CCM) and climate change adaptation (CCA). Both are expected to benefit from the implementation of NbS, in reducing GHG emissions and/or preventing emissions, while increasing resilience (adaptability) to changed conditions. Climate change mitigation considers actions that result in reducing net emissions of greenhouse gasses (GHG), contributing to the global initiative for GHG emissions reduction (Paris Agreement) which would reduce the rise of mean global temperature (global warming) or, ultimately, stop this increase at some value (2oC with respect to the preindustrial period, desirably at 1.5oC). Cumulative benefits from CCM interventions on local/national/regional scales contribute to global emission reductions. For successful CCM, results on global level counts, while no positive effect can be expected if cumulative results on global level do not reach expected targets. For this reason, CCM targets are usually regulated by international agreements. Climate change adaptation considers actions that result in mitigating negative impact of climate change, protection and adaptation of different sectors to climate change to ensure their full functionality under changed (changing) conditions. Implementation of CCA measures benefits on scales of intervention and, indirectly, on larger scales. For this reason, CCA measures implementation is regulated on national level (or with special international agreement if the problem crosses boarders). Because of the increasing negative impact of climate change on food production, environment, security and life quality of people worldwide, which can result

7 Climate system consists of atmosphere, hydrosphere, lithosphere, cryosphere and biosphere, and their interactions; in a certain context, it can be referred to as the Earth system.

8 "Great Acceleration" is known as rapid increase across a wide range of measures of human activities notable from mid-20th century with continuing accelerating growth rate including population, income, urban population, energy use, fertilizer consumption, water use, etc. Earth system trend data that measure the human impact on Earth system (surface temperature, terrestrial biosphere degradation, domesticated land increase, tropical forest loss, ocean acidification, carbon dioxide increase, etc.) show a growth trend in accordance with socioeconomic trends. Clear trends in these indicators beyond mid-20th century represent clear evidence for fundamental shifts in the Earth system state and functioning, beyond the range of Holocene (epoch after the last major ice age which ended about 11700 years ago).

9 EEA (2021) provides an overview of relations between societal challenges, NbS, and SDGs, including description of corresponding benefits.

in disturbances of regional/global scales (for example, food supply, migrations; Zastrow, 2015[10]), CCA measures implementation, monitoring and reporting became globally as important as for CCM measures[11]. For this reason, Nationally Determined Contributions (NDC) submitted to United Nations Framework Convention on Climate Change (UNFCCC) are requested to include, in addition to CCM targets, also the CCA component.

Many countries in their NDCs submitted to the UNFCCC in 2019 included measures that can be accounted as NbS as measures for CCA (104 NDCs out of 168), as measures for both CCA and CCM (77 NDCs), or only as a part of their CCM plans (27 NDCs) (EEA, 2021). Ability and ambition of the UNFCCC Parties to implement NbS differ depending on the regions, habitat types and economic development, and many do not include measurable targets supported by evidence (Seddon et al., 2020).

It is recognized that NbS could contribute up to about 20% of the mitigation needed between now and 2050 to keep the global warming below 2°C – without the use of nature services the target is not likely to be reached on time (Griscom et al., 2017). Such a large potential for CCM by implementing NbS worldwide triggered increasing interest in NbS implementation, especially as these solutions are meant to be cost-effective, partially or fully self-sustainable and with long-term gain.

Depending on the expected targets in future global temperature increase, NbS can provide additional benefits in reducing global temperature (because of the land use-related interventions they have an impact on surface-atmosphere interactions) in addition to their contribution in decreasing net GHG emissions, so this could be their primary contribution to global action in combating climate change. For example, in the study (Girardin et al., 2021[12]) which accounts for the implementation of NbS, which were not considered in global climate projections, in 1.5oC global warming pathway

10 Climate change is recognized as an additional threat for instability in Syria, because of the extreme drought from 2007-2010 experienced before the civil war. Drought, in addition to other stressors, may be responsible for triggering migrations, which exacerbated socio-economic stress. This gives an example of how future climate change impacts can be a threat multiplier for socioeconomic instability. It is not possible to derive a clear connection between climate change and conflict – none of the existing models or existing data processing can provide such estimation, but the inclusion of climate change information as an additional stressor to society is valid.

11 IPCC Sixth Assessment Cycle is currently underway and Working Group 1 Sixth Assessment Report (WG1 AR6) has been recentry published. WG1 AR6, IPCC Fifth Assessment Report, and IPCC Special Reports (Global Warming of 1.5oC – SR1.5; Climate Change and Land- SRCCL; Special Report on the Ocean and Cryosphere in a Changing Climate- SROCC) provide an undebatable evidence of the acceleration of climate change, in the near future even beyond tiping point, indicate the importance of limiting global warming and highlight great benefits from implementation of nature-based interventions in achieving the Paris Agreement goals with a contribution to food security, sustainable development and human livelihoods. SR1.5 and SRCCL summaries for policymakers are translated into Serbian.

12 Publication “Nature-based Solutions can help cool the planet – if we act now”, published by Nature, provides trajectories of global temperature by 2100 with and without the implementation of NbS – how they reduce projected peaks according to different scenarios and how, in addition to reducing/stabilizing GHGs, they reduce temperature values – “cool the planet”, referring to these NbS impacts as “The Long Game” meaning that their immediate implementation will provide an enhanced gain over long-term scales, even after 2100.

they are estimated to contribute to reducing global temperature peak by about 0.1oC, and in 2.0oC scenario, they are estimated to reduce peak by 0.3oC. Afterward, their impact on global cooling and reaching expected equilibrium is increasing. In 3.0 oC global warming pathway, NbS contribution could decrease because of the climate change stress which reduces the potential of NbS services.

NbS concept has recently been fully developed and a tool for helping users with NbS implementation is available (NbS Standard). Certainly, raising awareness on NbS, demonstration of their effectiveness, research on their design and potential and establishment of NbS monitoring-reporting-verification systems are essential for their adoption, successful implementation and further development.

Building climate resilience including adaptation to climate change with co-benefits to mitigation, through NbS implementation, requires NbS impact evaluation to assess the value of t NbS to the community, investors and policymakers. Good evaluation can be considered as a basis for effective NbS implementation, it contributes to evidence-based policymaking and to t implementation of adaptive management to serve flexible decision-making. Guidance for NbS evaluation and proper set up of NbS monitoring by selecting relevant indicators for different NbS approaches is given in *handbook* created for practitioners published by European Commission (EC, 2021[13]).

Since NbS can be designed to tackle climate change, biodiversity loss and land degradation, it can be considered as an integrated solution for the Countries' commitments to all three Conventions, United Nations Framework Convention on Climate Change (UNFCCC), United Nations Convention on Biological Diversity (UNCBD) and United Nations Convention to Combat Desertification (UNCCD), as well as already mentioned SDGs by 2030.

13 Publication "Evaluating the Impact of Nature-based Solutions: A Handbook for Practitioners" explains NbS concept and related knowledge (starting from the basics), evaluation and monitoring methodologies and provides guidance. It is designed for stakeholders involved in NbS assessment and implementation (researchers, engineers, authorities, and other project implementers)

Because of the proven significance of NbS in reaching Paris Agreement targets, the science highlights the need for UNFCCC to engage actively at the following COP meeting (COP26) in providing clear guidance on national-level accounting for NbS (Girardin et al., 2021). It should guide the targets set in NDCs, and methodologies for monitoring-reporting-verification to comply with these targets. It is recognized that this is the right way to ensure the longevity of NbS contributions to mitigation of carbon, to contribute to high biodiversity levels and to enhancing human well-being.

Box 1 provides a list of information related to NbS for climate change[14], that summarizes the meaning of NbS, their significance and important notes for their implementation.

BOX 1: NATURE-BASED SOLUTIONS FOR CLIMATE CHANGE FACTSHEET

- ✓ Also called *natural climate solutions*
- ✓ Consider conserving, restoring, or better managing ecosystems to remove carbon dioxide (CO2) from the atmosphere and/or to keep carbon from emitting, with high potential for adaptability to climate change
- ✓ Could contribute about 20% of the mitigation needed between now and 2050 to keep global warming below 2°C – without the use of nature services the target is not likely to be reached on time. Could reduce the peak of global temperature and continue to reduce global temperature by 2100 and after
- ✓ They are cost-effective over long-term scales, compared to engineered solutions
- ✓ Globally, four categories of NbS are considered: forestry practices, wetland-related practices, restorative agriculture, and ocean-based practices
- ✓ Potential co-benefits: cleaner air and water, control of land erosion, flood and drought protection, in general - increasing the resilience of other societal challenges; can be considered as an integrated solution for commitments to UNFCCC, UNCBD and UNCCD
- ✓ They can be reversible: captured carbon can be released in wildfires, as a consequence of bad land management practices, or disturbed system functionality under the climate change impact
- ✓ For the adoption of NbS outreach, education and trainings are needed: many stakeholders are not aware of NbS benefits. NbS can be self-sustainable in time, but benefit from upfront financing must be well understood to attract investors and other beneficiaries
- ✓ Good governance is essential to balance trade-offs in land: other land uses may be more attractive for short-term gain, but NbS would ensure long-term gain with reduced costs
- ✓ Good governance would ensure the sustainability of NbS and thereby protect captured carbon, while also ensuring adaptability to changing conditions
- ✓ Monitoring of NbS effectiveness is necessary to ensure its functionality, recognize potential problems and timely initiate the necessary interventions
- ✓ Investments in research over pilot areas are the initial step in designing new NbS and assess their effectiveness and potential for scaling-up; use them for demonstration of NbS effectiveness and results should be used for promotion to stakeholders

14 Mainly derived from **https://www.american.edu/sis/centers/carbon-removal/fact-sheet-nature-based-solutions-to-climate-change.cfm** and supplemented with additional facts

NATURE-BASED SOLUTIONS FOR CCM AND CCA IN SERBIA

Paris Agreement requests from countries to distinguish priority national actions related to CCM and CCA in the Nationally Determined Contributions (NDC) document, which should be submitted to UNFCCC after adoption by the national government. These actions, clustered on a global level, determine if the Paris Agreement goals will be achieved. Each country should implement actions and achieve goals which are determined in NDC. For this reason, in discussing the potential for implementation of NbS in Serbia, NDC priorities are explored, and according to them NbS contribution can be assessed and NbS measures designed.

In NDC of Republic of Serbia (currently in draft version), priority sectors have been identified: forestry, agriculture, water management, human health and biodiversity, and measures have been identified for disaster risk reduction from natural hazards. Measures included in NDC are created for solving the societal challenge – climate change, and they contribute to multi-challenge benefits (food and water security, disaster risk reduction, environmental and biodiversity degradation, human health, and, finally, economic and societal development – all affected by climate change). Selection of priority measures has been derived from national reports, action plans and strategic documents, etc. (a list of such documents is provided in Annex I[15]).

NbS are not explicitly mentioned in the current draft version of NDC of Republic of Serbia (measures have not been classified as NbS, nor has a full set of criteria which ensure prevention of their misuse – NbS concept has not been introduced), but this document includes measures that can be classified (considered as recognized) as NbS/ or part of the wider NbS/ or NbS can serve as an option for mentioned measure design and implementation. Proposed measures that include the use of nature services for climate change adaptation and mitigation are candidates for NbS, but certain self-assessments should be done, to prevent the misuse of the measures, to use their full potential and ensure their sustainability. This means that implementation of NbS Standard is strongly advised to perform a self-assessment to fit in NbS context. In addition to self-assessment of recognized measures (of past projects) that can be considered as NbS, as mentioned before, NbS Standard instructs how to design future projects, identify new NbS, and upscale pilots with gaps identification – this serves the future development of NbS concept in research, national reports, strategies, action plans, etc.

15 Territory of Serbia experience an increase in average temperature by 0.6oC per decade since the 1980s when the increasing trend became significant globally. Projected temperature increase under the "business as usual scenario" (RCP8.5) at the end of the 21st century is about 5oC compared to mid-20th century. Observed and projected climate data and climate change impacts are analyzed in different national documents and publications (like National Communications and other studies published at **https://www.klimatskepromene.rs/en/publications/**). Currently, Third National Communication is ongoing, as well as National Adaptation Plan and expected to be available in the draft version during 2021.

Measures that fit in NbS context and NbS that can be implemented in combination with engineered solutions, which have potential for CCM and CCA in Republic of Serbia, are considered in this study. Analysis was prepared using UNDP *seven-step approach* for enhancing NDC using NbS (DeSantis et al., 2019), including relevant literature overview, and represents an up-to-date collection of information related to the NbS implementation potential in Serbia, including gaps identification and recommendations.

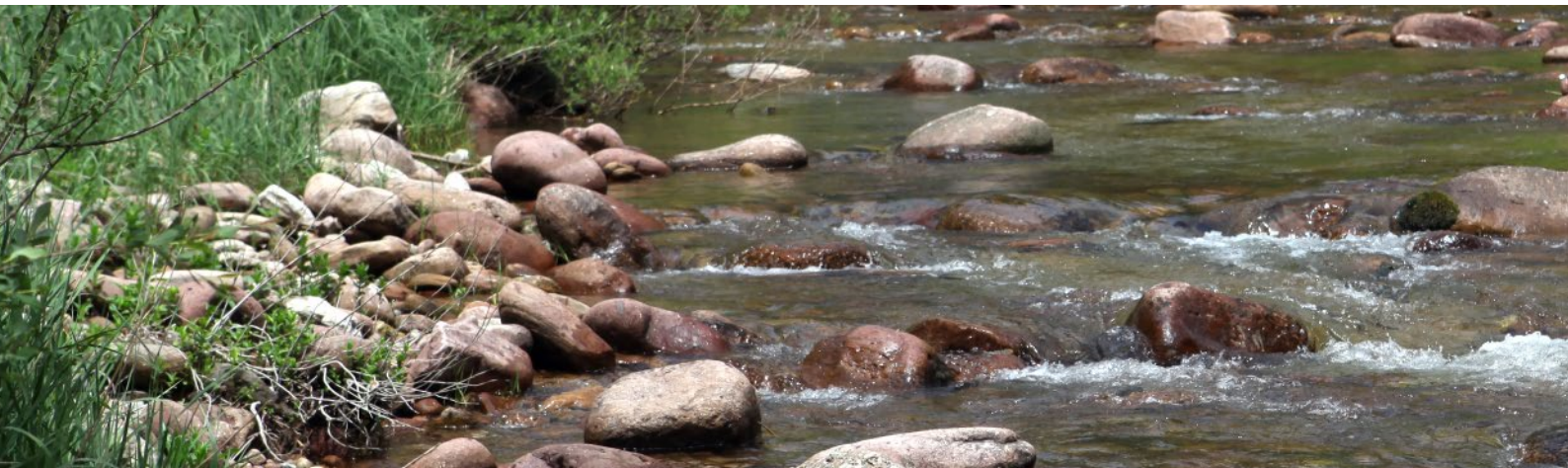
Table 1 shows a list of NbS measures with the potential to contribute to CCM and CCA in Serbia, their meaning, priority activities that are the main implementation actions for the specific measure and aim to additionally explain the measure itself (full set of actions related to each measure is much longer). More information on these measures are listed in Annex 2, Table A1 (sectors involved or affected, potential source of finance, and other relevant information, including assessed potential for GHG reduction, if available). Measures for which priority (with the largest benefit) sector is forestry (measures 1-5) are marked green, measures with priority benefit in the agriculture sector are marked orange (6-10), measures that target water conservation and with water management as the priority sector are marked blue, measures with priority sector related to urban management are marked grey (14-15), measures with the largest benefit in energy sector are marked yellow (16-18). All measures provide multi-sector benefits and can be considered as multi-challenge solutions. Intersectoral collaboration would be necessary for implementation of such measures that fits the context of *nexus approach* in CCA and CCM, which is recognized as best practice for proper design, prioritization and implementation of measures.

Measures 1-13, listed in Table 1 and A1, are measures that can be considered as NbS and are related to forestry practices, wetland-related practices, restorative agriculture. For example, in afforestation: this measure considers the change of land use to forest land or increase of the canopy cover over a certain threshold, can be NbS for prevention of soil erosion and its co-benefit is that it enhances CO2 sink potential, if implemented properly it can be self-sustainable, which is the final goal of NbS. Measures 14-18 are NbS that can be used in combination with engineered solutions. For example, energy production from biomass: supply of material for energy production is NbS, but the process of energy production is an engineered solution. They are also designed to serve the sustainability of sectors, their adaptability to CC, and to contribute to the reduction of GHG emissions if used instead of materials which have higher processing emission rates.

Afforestation and reforestation (measures no. 1 and 2 in Table 1) are included in draft NDC of Republic of Serbia, with a high contribution to CCM (afforestation) and CCA (reforestation). Afforestation needs plots selection, with priority goal of reducing soil erosion, which serves CCA while a co-benefit to CCM can also be considered. Reforestation serves also CCA, but co-benefit to CCM should be assessed. Measure related to forest management is included in NDC as CCA (close to nature management, no.3 in Table 1), but implementation as NbS would require self-assessment according to NbS Standard and co-benefits to CCM should be considered. Fire management (no. 4) and integrated pest management (no. 5) can be considered as included in NDC under the measure related to reducing negative risk factors (biotic and abiotic) for forestry, but the implementation of this NDC measure should consider actions related to fire management and pest management as NbS and their contribution to CCM should be assessed.

Agroforestry is found to have significant potential for CCM and CCA in Serbia but is not included in NDC for agriculture sector. It can be considered under afforestation when plots selected for afforestation constitute agricultural land used for production or pastures or plots dedicated for shelterbelts. This means that afforestation measure can be extended to agriculture as a measure for increasing canopy over a certain threshold (as given in the description of afforestation measure meaning in Table 1). Conservation agriculture & nutrient management (measure no. 7) can be considered as included in NDC under CCA measure for agriculture as adjustment of the technologies of agricultural plant and animal production. In the implementation of this NDC measure, however, the proposed NbS should be considered as an alternative or a supplement to other solutions, and its full potential assessed for CCA and CCM. Measure no. 8 in Table 1 is introducing biochar, as a natural product that is used for improving soil qualities for both carbon sequestration and soil health benefits. It is not considered under priority measures, and its potential for use and benefits should be explicitly assessed for Serbia. Measure no. 9, to improve livestock and pasture management, can be considered as NbS measure under adjustment of animal production to climate change, but its implementation as NbS requires research on best practices and a more detailed analysis of climate change impacts. Measure no. 10, which considers restoration of abandoned agricultural sites using NbS, has potential for implementation in Serbia considering the assessed surface of such areas (about 10% of agricultural land). These surfaces can be a candidate for a change of use (afforestation) which means they would change their purpose and not be considered as restored, but the implementation of agroforestry can be NbS for restoration. Multi-use of such sites can be proposed – for agricultural production and solar energy, selected NbS can be combined with an engineered solution to enhance its cost-effectiveness. Implementation of multi-use on such sites is advised because they have lower production potential, and multi-use of space for both practices can co-benefit better exploitation of the site potential.

Measure no. 11, peatland restoration, is not included under NDC measures, its potential for implementation and benefits should be explicitly assessed for Serbia. Highest contribution of this measure is to water and biodiversity conservation. Measure no. 12, floodplains restoration, is a measure that provides benefits in protection from flooding and potentially from droughts. It is not included in NDC but can be considered in future climate change plans as a solution for disaster risk reduction and co-benefits for irrigation/drainage system developments. Measure no. 13, conservation of wetlands (peatlands), is transforming the existing wetlands into adaptive systems (to climate change) that can be self-sustainable and that can provide needed services which are expected from implementation of this measure. Such systems, among other functions, are conserving water (needed for adaptation to climate change) and biomass (mitigation benefits). Research studies, related to best practices under climate change are needed, and potential for its implementation and co-benefits to climate change mitigation should be assessed for Serbia.



Measures no. 14-15, are related to urban planning and construction, targeting enhancement of green surfaces in urban areas and reducing consumption of surfaces. Green surfaces can be considered as plots for NbS implementation that affects reduction of climate change impact and improvement of air quality, microclimate, and finally health. If these measures are planned as NbS or a combination of green-grey solution, it is important to avoid potential misuse, because green surfaces should be self-sustainable (for example, in water needs, and climate adaptable), and not damaging to health (for example, plants with minimal risk of allergic reactions).

Measures related to alternative materials for energy production, which are provided by nature services, are considered as measures no. 16-17. They can be considered as recognized indirectly in NDC as a measure for increasing the use of renewable energy solutions in energy and heat production. Potential for their implementation and co-benefits to CCM should be explicitly assessed for Serbia. Potential for the use of natural building materials (measure no. 18) in Serbia is also not assessed but can be considered as a measure for the improvement of thermal integrity and it can contribute to increasing energy efficiency. Implementation of climate-smart materials, which are also environmentally friendly can be considered.

Table 1. Measures that can fit in the NbS context or can be used in combination with engineered solutions, with potential for implementation in Serbia; the meaning of proposed measures, priority actions for implementation in Serbia, and additional relevant comments

No	Measure	Meaning	Priority Action	Comments
1.	Afforestation	Process that considers change of land use to forest land or increase of the canopy cover to above the 10% threshold	• Plots selection (including site mapping) • Selection of adaptable/resilient tree species • Establish a monitoring system • Education and trainings • Production of planting material	Recognized in t NDC for CCM; Range of costs is identified; Possible need for trade-offs with other sectors for plots selection - good governance necessary; Consider the potential of this measure for CCA
2.	Reforestation	Process that considers restocking of existing forests that follow harvesting of mature trees or degraded forests or shrubs	• Site mapping • Denser planting for increasing productivity • Selection of tree species mixtures (site- and climate- adaptable), including high-productivity species • Establish a monitoring system	Recognized in NDC for CCA; Range of costs is identified; Good governance would ensure proper implementation and continuous monitoring; Consider the potential of this measure for CCM (woody biomass resources, improved forest productivity – improved carbon sequestration)
3.	Sustainable Forest Management & Close to Nature Forest Management	Implementation of measures that serve to optimize multiple forest functions and to promote natural forest regeneration, such as: species selection, rotation length and management regime (incl. sustainable harvesting levels, planned thinning and low-impact logging); conversion of suitable coppice forests; harvesting of over-mature stands; an increased mixture of tree species suitable for climate change resilience - increased productivity	• Selection of three species for increasing admixture by regeneration of high forests, through the conversion of coppice forests and the regeneration of over-mature beech stands • Preparation of management guidelines • Establishment of demonstration and research plots – do pilots • Monitoring-reporting-verification	Recognized in NDC; Range of costs is identified; Further research is necessary to reach full potential of this measure(s); Can increase soil organic carbon and biomass; Guidelines for successful implementation of measure(s) are necessary to prevent misuse. This measure transforms forests into climate change- resilient ecosystems.
4.	Fire management in Forests	Process of planning, preventing and fighting fires to protect people, property and the forest resource. As NbS measure could consider improved land use planning for suppressing the spreading of fires and improved infrastructure for accessing remote areas.	• Preparation of prevention management guidelines • Education and training on the practical implementation of fire prevention management guidelines for foresters and fire-brigades • Establishment of an appropriate mechanism for the monitoring of wildfires • Consider implementation of preventive fire management as NbS in land use planning	Recognized in NDC; Range of costs identified; Promote fire management as NbS measure to increase resilience to fire because of the increasing risk caused by climate change impact.
5.	Integrated pest Management in Forests	Use the information on the life cycles of pests and their interaction with the environment to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment	• Preparation of prevention management guidelines • Establishment of an adequate monitoring mechanism for the monitoring of biotic factors as part of the national Forest Information System • Education and training on the practical implementation of the prevention management guidelines for forest engineers	Recognized in NDC for CCA; Range of costs identified; Assess contribution to CCM since the implementation of this measure contributes to preserving forests' health and thereby maintaining carbon from releasing into the atmosphere.
6.	Agroforestry Implementation: 1. Trees on cropland 2. Sylvo-pastoral systems	1. Afforestation with climate-smart tree species in agricultural crops & formation of shelterbelts around crops 2. Integration of fodder plants with trees and shrubs, while benefiting from grazing	• Conduct research on pilot fields selection and species selection • Implementation in pilots sites and assessing the potential for scaling-up • Develop management guidelines; advisory services; training • Monitoring-reporting-verification	Not included in NDC; This measure can be coordinated with afforestation, depending on the field size and on what is defined as "forest" land. This measure can reduce pressure in trade-offs for plots selection between sectors of forestry and agriculture. This measure could reduce the risk of land degradation and provide sustainability of food production

7.	Conservation Agriculture & Nutrient Management	Ensuring a permanent vegetation cover throughout the year, e.g. through leguminous crops (used as fertilizers) or mulching. Another principle is zero tillage. & Optimizing the inputs of fertilizers and outputs of crops	• Research pilot areas if needed and use them to demonstrate the measure success • Manage guidelines development and trainings organized by the agricultural advisory service • Monitoring-reporting-verification	Recognized in NDC for CCA; Guidelines and education are essential to attract beneficiaries (producers). Monitoring system should include producers' feedback. Can reduce risk from soil erosion and improve water retention.
8.	Biochar Use	Conversion of biomass residues and organic waste, and sewage sludge to biochar and its application to crop fields and pastures	• Conduct a feasibility study • Conduct a pilot demonstration study and assess the potential for scaling up • Monitoring-reporting-verification	Not included in NDC; Can reduce risk from soil erosion and improve water retention. Can be combined with conservation agriculture measure and improved pasture management. Can contribute to NbS for energy (form biomass and natural material waste)
9.	Improve Livestock and Pasture Management	Grazing optimization improved nutrition through feeding high-energy dense feeds, manure management, improving livestock breeds.	• Prepare management guidelines considering climate change risks, for direct implementation • Research new practices and demonstrate best/new practices performance in pilots • Research on climate change impacts and species selection, and pasture and breeding management • Establish a national breeding programme • Improve livestock housing using natural materials • Monitoring-reporting-verification	Recognized in NDC; Range of costs identified; Consider combining with agroforestry measure, where possible. Can contribute to reducing the risk of land degradation and improve water retention
10.	Restoration of Abandoned Agricultural Sites	May consider agroforestry implementation, implementation of a combination of agricultural activities and technical solutions for the production of clean energy (for example solar energy) - multiple uses of agricultural surfaces	• Select pilot areas • Conduct a study on this measure performance • Assess the potential (map abandoned agricultural surfaces) and effectiveness of scaling up • Provide management guidelines and trainings	Not included in NDC; Soil quality improved through restoration measures, retention of carbon, prevention of erosion and related risks
11.	Peatland Restoration	Management measures that aim to restore the original form and function of peatland areas to a favourable conservation status (stop drainage and rewetting)	• Conduct research on peatland restoration potential and vulnerability of peatland to climate change • Select pilots and actions (revegetation, vegetation management, optimization of wetness conditions) to assess feasibility and benefits • Assess benefits and risks from the implementation of this measure on larger scales	Not included in the NDC; This measure may require trade-offs between different sectors if peatland surfaces are affected by actions from another sector. Education on peatland restoration is probably necessary for gaining support for its implementation. Can improve water quality and biodiversity, and store carbon
12.	Floodplain Restoration	Reduce water-related risks (floods and droughts) while improving water quality and quantity	• Connection of retention areas for the irrigation and drainage system development • Connection of depressions with existing channels; building of floodgates on channels; building of floodgates on dams; tunnelling of forest roads for a controlled water run-off • Land use change from "non-forest" to forest land • Land use change from artificial and agricultural land to forest land and wetland, particularly with native vegetation • Select pilot areas and demonstrate the effectiveness of listed actions	Not included in NDC; Can be considered as a "green" option for irrigation/drainage-related measures which were included in NDC and to assess the potential for reverting engineered solutions to NbS in the future. This measure may require trade-offs between different sectors if surfaces are adapted for different use. Can mitigate flood and drought impacts.

13.	Wetland/Peatland Conservation	Wetland management and protection through governance, law enforcement in protected areas of wetlands/peatlands	• Adoption of the Wetlands/Peatlands Protection Act • Research on wetlands/peatlands vulnerability to climate change, and on measures for increasing resilience • Implementation of established conservation measures defined by including information on climate change impact • Monitoring-reporting-verification	Not included in NDC; Wetlands are vulnerable to climate change because of the increasing frequency of droughts and heatwaves. Conservation of wetland under climate-changing conditions contributes to conserving water (mitigates drought risks) and biomass (prevents increasing emissions)
14.	Enhance Green Infrastructure in Urban Settlements	Enhance natural areas and features in and around cities to perform essential ecosystem services	• Identify plots for the reconstruction of natural surfaces • Ensure site and climate change adaptability through species selection • Select pilots and demonstrate the effectiveness of listed actions and assess the potential for scaling up • Promote the solution to local governments and investors	In NDC for CCA, proposed measure is the development of action plans for responding to climate change in urban areas and this measure can be considered as an option for a solution; This measure can benefit to public health and climate change impacts (extremes) mitigation in urban areas. Should be strongly promoted to local governance
15.	Minimizing Land Consumption in Urban Planning	Spatial and urban planning to control the expansion of urban areas against natural ecosystems	• Include experts from different sectors dealing with natural ecosystems • Assess potential for increasing resilience to climate change in urban settlements by reducing land consumption • Educate governments and investors	In NDC for CCA, proposed measure is the development of action plans for responding to climate change in urban areas, and this measure can be considered as an option for a solution; Co-benefits are in the health sector
16.	Use Energy from Biomass	Introduction of biomass as fossil fuels substitution	• Identify existing practices or implement pilots and assess effectiveness and potential for scaling-up • A research study on the identification of potentials of different biomass sources at the national level • A study on the option of using a mobilization mechanism for different biomass sources (financial, legislative, advisory) • Feasibility studies for sustainable consumption of combined biomass sources for the use of biomass from different sources • Explore financing options from the sectors of Energy, Agriculture, Environment, and Forestry	Recognized in NDC as a contributor to CCM; Can contribute to ensuring sustainability in energy supply, because energy production fits in the natural cycle. Can contribute to improving air quality and a healthier environment
17.	Use Energy from Natural Material Waste	Use of natural material waste as an energy source for the supply of combined heat and power facilities or biogas facilities	• A research study aimed at the identification of natural waste material sources • A study on the options for a mechanism (financial, legislative, advisory) of natural waste materials mobilization for different natural waste materials • Feasibility studies on a sustainable natural waste materials consumption • Implement pilots - assess effectiveness and potential for scaling-up • Explore financing options from the sectors of Energy, Agriculture, Environment and Forestry	Recognized in NDC as a contributor to CCM; Can contribute to ensuring sustainability in energy supply, because energy production fits in the natural cycle. Can contribute to improving air quality and a healthier environment
18.	Use of natural building materials	Green building materials are raw and processed nature-based materials used in the construction of the built environment	• Promote use via different information measures, as well as with certain incentives • Increase and optimize the production of climate-smart materials • Install “green” materials - substitute materials with a higher grey energy consumption	Recognized in NDC as a contributor to CCM; Production and processing should result in low environmental impacts

In the listed measures that can be considered as candidates for NbS or green-grey combination measures, there is mutual overlapping and that with NDC measures. For this reason, and to ensure the proper use of NbS context, a self-assessment of existing/proposed measures with recognized potential in Serbia should be done according to NbS Standard. Advised approach is to focus on one (or a few) NbS, with co-benefits in combatting different challenges and in different sectors, and use its full potential, rather than to split activities and dissipate to different NbS measures which would increase costs and increase the risk of NbS misuse. This also means that list of proposed measures in Table 1 should not be addressed separately, but their interconnection should be considered. Starting point in joining "potential measures" into one NbS with higher potential, should be the fact that NbS starts from interventions implemented on land cover and soil.

The contribution of some NbS to CCA on the national level may not be significant compared to other solutions, especially the ones with high co-benefits to CCM, but on the local level may have high potential. For this reason, promoting NbS to local governments is desired.

Some of the listed measures that can be classified as NbS with agriculture as a priority sector are considered in the publication on observed and projected climate change impacts on agriculture in Serbia (Stričević et al., 2019), which was compiled from the material prepared for Third National Communication (TNC, under construction). Thereby, it may be expected that upcoming TNC will include a broader consideration of NbS measures, as well as their inclusion in National Adaptation Plan (NAP, under construction), and other upcoming relevant documents. Besides their adaptation potential, the mitigation potential of NbS measures needs to be assessed including their impact on GHG net emissions reduction as well as their impact on the cooling effect in the

area of implementation. Prioritization of NbS needs to be carefully approached considering the benefits they provide on different scales (spatial and temporal).

Box 2 provides the most relevant notes about NbS for CCM and CCA in Serbia and actions important for their implementation.

BOX 2: NATURE-BASED SOLUTIONS FOR CLIMATE CHANGE IN SERBIA

- ✓ *Nature-based solutions* context, according to its full definition, is still not implemented in national documents – it is a relatively new and recently developed concept for societal challenges solution
- ✓ Climate change mitigation and adaptation measures that are recognized in national documents and in NDC of Serbia, which can fit the NbS concept – should be self-assessed according to the NbS Standard and potentially classified as NbS
- ✓ The potential for the implementation of combined green (NbS) and engineered solutions, rather than only engineered solutions, for climate change, should be explored
- ✓ Co-benefits from different measures and multi-sector benefits should be assessed including their potential for implementation as the NbS – joining measures are advised for using their full potential, reducing costs and fitting into the nexus context of CCM and CCA
- ✓ Full potential for NbS implementation and related gain in Serbia is still unknown
- ✓ Implementation of the NbS for climate change can have support from international funds
- ✓ Raising awareness, targeting investors and governments, is necessary – needs to be well explained (evidence supported) cost-effectiveness of NbS
- ✓ Investment in research projects and demonstration case studies is necessary

CREATING ENABLING ENVIRONMENT FOR SUCCESSFUL IMPLEMENTATION OF NATURE-BASED SOULUTIONS

Success factors for NbS projects planning, conception and implementation have been identified, to include, in addition to good management, choice of partners and other general success factors, also building strong support in strategies and policy, support from local governments and citizens, as well as education of youth (Naumann et al., 2014). These factors are meant to ensure adoptions of NbS as a solution and to NbS achieve its full potential and provide long-term gain.

Nature-based Solutions are recognized as measures to tackle climate change at a low cost, but usually needing immediate investments and sometimes trade-offs while requiring a certain time for reaching full potential and they serve as a sustainable response. In other words, patience means profits concerning NbS. NbS project needs to have a strong scientific background (knowledge and data) and, if uncertainties emerge, learning from case studies with scalable potential is advised according to NbS Standard. With the implementation of NbS, as mentioned before, it is best to address CCA and CCM with co-benefits to other challenges including multi-sectoral collaboration. Any uncertain try-outs of different and not carefully planned NbS (according to NbS Standard guidelines) would mean a waste of funds and time, potentially leading to increasing challenges. To ensure the NbS success it is important for the NbS assessment to predict outcomes and possible obstacles with prediction uncertainty reduced to a minimum. Ensuring sustainability of NbS as a fully functional solution requires enhancing resilience to change of governments and private sector interests through policy/regulations, gaining the trust of locals and involving youth. Strong promotion of the NbS project, including assessment of future benefits, in a transparent way, would build long-term support, a sense of ownership, and maintenance/improvement mechanisms including a regular monitoring-reporting-verification system. In addition to including volunteers in project implementation, the project might have the potential of creating local jobs, for example as short-term engagements during the implementation phase or jobs related to maintenance of the NbS functionality and monitoring of indicators.

Table 2 provides outlines of enabling environment factors for good practice in NbS opportunities analysis, NbS selection, project planning, t kick-off of the project, its successful implementation, and ensuring its sustainability.

Table 2. List of enabling environment factors that suggest actions which would help successful NbS project selection, planning, kick-off, implementation and ensure the NbS sustainability.

CREATE ENABLING ENVIRONMENT FOR SUCCESSFUL NBS PROJECT DEVELOPMENT, IMPLEMENTATION AND ITS LONG-TERM SUSTAINABILITY AS SOLUTION AND SERVICE PROVIDER				
Pre phase	**Planning**	**Beginnings**	**Implementation**	**Sustainability**
• review of existing measures with NbS potential • review of current knowledge on measures with NbS potential • seek the support of such measures in national documents (reports, strategies, plans) • include relevant experts to select the opportunity (opportunities) • decide on the project(s) that will produce NbS	• search for the area options for the project implementation • build support for the project in strategies and policy • secure political support: promote the project to local government in the area of implementation • involve relevant participants and beneficiaries including the local population • build the trust of the public and raise the awareness of stakeholders • secure access to selected area	• communicate benefits • select partners and actors • create efficient communication mechanisms and create contacts in the local area • act in the multi-sector environment: relate beneficiary sectors and prove mutual interactions and benefits • secure project basis in science and evidence (data/information) • secure sufficient funding with flexible options: possible trade-offs among different project stages	• allow flexibility to a certain range in actions implementation: open to adjustment according to new viewpoints and scientific knowledge • continuous personal engagement of project representatives in the area of implementation • dedicate an experienced project manager, ensure good project management and work with partners • educate youth - involve them in some activities, involve volunteers • create job opportunities • keep a sense of ownership among actors • nurture transparency thro-ugh regular communication with actors and locals	• ensure sustainability through policy and regulations • reduce the vulnerability of project long-term success on change of governance • protect an area of implementation from potential disturbance damaging to solution functionality • build long-term local support through education, sense of ownership, and provided guidance for support • ensure monitoring-reporting-verification of the NbS indicators and build opportunities for maintaining/improving quality performance

CONCLUSIONS AND RECOMMENDATIONS

Transforming adopted measures for CCA and CCM in NbS

Nature-based Solutions for climate change mitigation and adaptation are not explicitly recognized in national documents and strategies of Republic of Serbia. Some priority measures recognized by the revised NDC (currently in draft version) can fit NbS context, but to avoid their misuse, to reduce risks that may prevent achieving their full potential and increase costs, and to ensure their sustainability/durability, NbS Standard should be implemented. Assessment of measures is required as NbS may affect cost, actions planning, expected gains, and also to ensure their sustainability. Adopting NbS Standard for self-assessment of existing solutions and designing new NbS is the right way for NbS implementation. Implementation of one NbS, well planned to serve multi-sector benefits, is more effective than dissipation of efforts and funds on many NbS which are found to have interconnections. The possibility for transforming engineered solutions into combined solutions (engineered and NbS and potentially "soft" solutions such as the use of climate change and forecast data and information) should be explored. Assessment of their potential to transform eventually to a fully NbS measure, if applicable, is also desired.

- ✓ *Adopt NbS Standard* as a guideline for successful NbS implementation and prevention of its misuse
- ✓ *Revise selected measures to fit the NbS context* according to NbS Standard
- ✓ *Include NbS context in the current NDC draft in form of intention* so that in the project planning stage for the implementation of CCA and CCM measures NbS approach will be considered (where appropriate), assessment of NbS potential will be provided, and NbS will be adopted in case the assessment shows a prediction of a positive outcome.

Build support for future NbS projects implementation

Measures for climate change adaptation and mitigation need to be adaptive to changing climate conditions with increasing extremes and resilient to socio-economic conditions including change of governments and interests of the private sector, to provide expected gains. While NbS by definition include adaptability, a positive environment for building support from- and resilience on- human factors needs to be developed. Promotion and education are needed to raise awareness about NbS, as cost-effective and sustainable solutions for climate change, with their multiple purpose in increasing resilience of different sectors. Researchers need to be engaged to study the implementation of NbS best practices, and investors and governments to enable the implementation of NbS. Pilot studies for verification of NbS and demonstration of benefits should be done. In this way, NbS will be included in national strategic documents, national reports, and, ultimately, in policy framework. Direct implementation of measures in NDC, without their background in other documents, is not likely to happen. Education and building support from local citizens including youth, in the area of implementation, is strongly advised, which would contribute to NbS achieving its full potential.

- ✓ *Invest in increasing knowledge on NbS* successful practice by investing in research including case studies with potential for scaling up
- ✓ *Build support for NbS approach in national documents* including reports (like National Communication), strategies and action plans.
- ✓ *Build a positive environment for improvement of knowledge and attitudes* for adoption of

NbS context by promoting benefits of NbS implementation to scientific community, governments, stakeholders and citizens, as a measure for tackling climate change cost-effectively and sustainably with multiple benefits.

- ✓ *Consider NbS as an integrated solution* for commitments under three UN Conventions (UNFCCC, UNCBD and UNCCD), with multiple benefits to different sectors.

Consider NbS potential on different scales

Assessment of NbS potential on national and local levels may differ, meaning that NbS may have low potential and benefits on national level but high gains on local level. For this reason, in NbS prioritization and planning, local scale benefits need to be considered to reduce unintentional disregard for solutions that may provide significant services on a smaller scales, and with this potentially reduce national costs of climate change impacts and some of them can provide co-benefits in the reduction of energy consumptions from current production plants.

- ✓ *Consider NbS benefits on local level* in the process of NbS prioritization, selection and planning.

Serbia is currently drafting its Third National Communication and National Adaptation Plan, which could comprise a wider range of recommended measures that fit the under the NbS umbrella. In addition to their CCA potential, there are added values in their contribution to CCM, their possible increasing effectiveness in the farther future, and their ability to address commitments to three conventions (UNFCCC, UNCBD and UNCCD). Because of the "act now" recommendation in the NbS implementation, as advised on global level to achieve expected benefits, immediate action is expected on national level. For this reason, it is preferable to introduce NbS concept tentatively in current drafts of national documents and plans rather than to wait for the full cycle of assessment and prioritization process, which means to provoke NbS consideration among different stakeholders.

Further reading on NbS for climate change in Serbia can be found in the previously published studies: *Study on Nature-Based Climate Solutions in Serbia* (Popovicki, 2019) and *Nature for Climate Briefing: Strengthening Nature-based Solutions within Serbia's Nationally Determined Contribution* (UNDP, 2020).

ANNEX 1

Initial National Report of the Republic of Serbia Under the United Nations Framework Convention on Climate Change, 2010, Ministry of Environment and Spatial Planning of the Republic of Serbia (also referred to as First National Communication).
The Second National Report of the Republic of Serbia under the United Nations Framework Convention on Climate Change, 2017, Ministry of Agriculture and Environmental Protection of the Republic of Serbia (also referred to as Second National Communication).
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The Second Biennial Update Report of the Republic of Serbia under the UNFCCC (in preparation)

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National Renewable Energy Action Plan of the Republic of Serbia, 2013, Ministry of Energy, Development and Environmental Protection of the Republic of Serbia
Serbia's First National Adaptation Plan (draft), 2015, Ministry of Agriculture and Environmental Protection of the Republic of Serbia

Law on Disaster Risk Reduction and Emergency Management of the Republic of Serbia
Law on Waters of the Republic of Serbia
Law on Climate Change of the Republic of Serbia

ANNEX 2

Table A1 Supplement to Table 1

No	Measure	Sectors	Finance	Additional information
1.	Afforestation	**Forestry**, Environmental Protection, Biodiversity, Energy	Private investors and national funds; Green Climate Funds; Budgetary Forest Fund contributed by revenues (emission trading)	GHG reduction potential -25.9 Mt/year of CO2. Planned annual afforestation is 5000ha/year until 2030, extending to 2050 (forest carbon sink +17%). (1-3 measures can be combined in one measure)
2.	Reforestation	**Forestry**, Environmental Protection, Biodiversity, Energy	Green Climate Fund; Green Environmental Facility; Funding can be refinanced from additional carbon sequestration (carbon projects)	About 23000 ha of forest (out of a total ~2.3mlion ha) each year is reforested. Actions of improvement can lead to a 10-50% increase in productivity (1-3 measures can be combined in one measure)
3.	Sustainable Forest Management & Close to Nature Forest Management	**Forestry**, Environmental Protection, Biodiversity, Energy	Joint financing from sectors: Forestry, Energy and Environment. Forest owners could participate in co-financing, supported by the Ministry of Environmental Protection and international climate financing schemes (for example Green Climate Fund).	GHG reduction potential: about -1Mt until 2030 of CO2 equivalent. Can be applied over the total forest area in Serbia (~2.3milion ha: 53% state forest, 47% private forests). Until 2030: close-to-nature management at 3000ha, conversion of coppice forests 70000ha, regeneration of over-mature beech stands 42000ha
4.	Fire management in Forests	**Forestry**, Environmental Protection, Biodiversity, Agriculture, Disaster risk reduction	National funds (0.5mil EUR up to 2030 for reduction of risks, abiotic and biotic factors); International funding schemes (GCF, etc.).	This measure as a NbS can be considered under sustainable risk reduction from increasing extreme events caused by climate change – can be considered as part of planning 1-3 measures implementation, for risk reduction
5.	Integrated pest Management in Forests	**Forestry**, Environmental Protection, Biodiversity	National funds; (0.5mil EUR up to 2030 for reduction of risks, abiotic and biotic factors); International funding schemes (GCF, etc.).	This measure as NbS increases resilience to climate change – reduces risks and preserves biodiversity (pests management should include climate change information); Can be integrated with other measures related to forestry, environment, biodiversity
6.	Agroforestry Implementation: 1. Trees on cropland 2. Sylvo-pastoral systems	**Agriculture**, Forestry, Environmental Protection	Self-financing from agriculture sector; Support from European Union funding schemes (European Fund for Rural Development), and other international funding schemes (Green Climate Fund,…)	GHG reduction potential -2.72 Mt/year (based on world data assessment – mora accurate assessment needs to be done on national level); Implementation of agroforestry systems costs an average of 1000 EUR/ha (depending on areas characteristics and specifics of interventions)
7.	Conservation Agriculture & Nutrient Management	**Agriculture**, Environmental Protection	National grant programmes; Revenues from emission trading system; European Agricultural Fund for Rural Development	GHG reduction potential: about -1Mt/year (only considering nutrient management, rough estimate, not explicitly calculated for Serbia), can be applied at 36% surface of Serbia
8.	Biochar Use	**Agriculture**, Energy, Environmental Protection	Renewable energy funding scheme; Businesses at the local and regional level; Emission trading system	GHG reduction potential: about -1Mt/year (rough estimate, not explicitly calculated for Serbia), can be applied to 46% of the cropland and pastures in Serbia

9.	Improve Livestock and Pasture Management	**Agriculture**, Environmental Protection	Emission trading system; European Agricultural Fund for Rural Development; Joint funding from different (affected) sectors	GHG reduction potential: 0.25 Mt CO2e/year for optimal grazing management and 0.02 Mt CO2e/year for grazing legumes in pastures (rough estimate, probably underestimated because not all measures were considered)
10.	Restoration of Abandoned Agricultural Sites	**Agriculture**, Environmental Protection, (Energy -if introduction measures related to energy production is chosen)	Sectors (or joint) funding; Climate change-related funds	About 10% of agricultural land in Serbia can be considered abandoned, and suitable for restoration. Potential for GHG reductions should be estimated considering chosen measures for restoration.
11.	Peatland Restoration	**Water management**, Environmental Protection, Biodiversity	Sector (or joint) funding; Environmental funds	GHG reduction potential: about -0.15Mt/year (rough estimate, not explicitly calculated for Serbia)
12.	Floodplain Restoration	**Water management**, Environmental Protection, Biodiversity	Sector for water management (joint funding from affected sectors); International funds for processes related to EU water policy	Climate change mitigation potential not assessed and could contribute to afforestation mitigation potential
13.	Wetland/Peatland Conservation	**Water management**, Environmental Protection, Biodiversity,	Sector for Environmental Protection; Serbia signed The Convention on Wetlands – possible access to related international funds; Climate change funds	GHG reduction potential: about -0.13Mt/year (rough estimate, not explicitly calculated for Serbia)
14.	Enhance Green Infrastructure in Urban Settlements	**ESpatial and Urban Planning**, Environmental Protection, Public health	Sector (or joint) funding; European Fund for Rural Development; Green Climate Fund; Private investors supported by international climate change funds	Climate change mitigation potential not assessed, area for assessment is about 4.8% of the territory of Serbia
15.	Minimizing Land Consumption in Urban Planning	**Spatial and Urban Planning**, Environmental Protection, Public health	Sector (or joint) funding; European Fund for Rural Development; Green Climate Fund; Private investors supported by international climate change funds	Climate change mitigation potential not assessed, area for assessment is about 4.8% of the territory of Serbia
16.	Use Energy from Biomass	**Energy**, Agriculture, Environmental Protection, Forestry	Sector (or joint) funding; European Fund for Rural Development; Green Climate Fund; Nationally Appropriate Mitigation Action; forestry fund for biomass production	GHG reduction: 0.65 Mt CO2 eq until 2030; full potential from the implementation of this measure for Serbia is not estimated.
17.	Use Energy from Natural Material Waste	**Energy**, Agriculture, Environmental Protection, Forestry	Sector (or joint) funding; European Fund for Rural Development; Green Climate Fund; Nationally Appropriate Mitigation Action; Private investors	Climate change mitigation and adaptation potential are not considered. Natural waste policy and strategy at national or local level could be adopted in a relatively short period which can generate positive GHG effects at national and local levels.
18.	Use of natural building materials	**Energy**, Construction, Environmental Protection	Climate change funds; Private sector	Climate change mitigation and adaptation potential not assessed. This measure is proposed to be developed in sector policy documents that should provide conditions for its implementation, as well as financial mechanisms for the implementation support

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