BRIGAID

Update of the Testing and Implementation Framework (TIF) for Climate Adaptation Innovations

Update of the Final Version of the TIF

Deliverable 5.4

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Table of Contents

1 Introduction 3

Report Organization 3

2 Updated version of Appendix C 5

A Test and Implementation Framework (TIF-Tool) for Climate Adaptation Innovations: Tool Guidance (Version 1.3; January 2019) 6

TABs of the TIF-Tool Version 1.3 27

3 Appendix G Practice-oriented validation of the TIF-Tool after stocktaking cycle 1 and 2 37

3.1 Background 37

3.2 Preparation phase - TIF-Tool V0 (version 0) 37

3.3 TIF-Tool V1 (version 1) 38

3.4 TIF-Tool V1.2 (version 1.2) 41

3.5 TIF-Tool V1.3 (version 1.3) 43

4 Outlook TIF-Tool 44

Preface

The present report (BRIGAID Deliverable 5.4) refers to Deliverable 5.2 'A Testing and Implementation Framework (TIF) for Climate Adaptation Innovations', and provides the updated version of the TIF-Tool (Version 1.3) and the accompanying guidance document (Appendix C in Deliverable 5.2), and reports on innovator feedback from the application of the TIF-Tool in stocktaking cycle 1 and 2 and from the workshop on the application of the TIF-Tool (new Appendix G). The final and completed version of the 'Testing and Implementation Framework (TIF) for Climate Adaptation Innovations' will be submitted in month 48. In this final version all updates will be integrated, including updates forthcoming from stocktaking cycle 3 and feedback from e.g. the planned workshop with professionals from water boards.

1 Introduction

BRIGAID's full version of 'A Testing and Implementation Framework (TIF) for Climate Adaptation Innovations' (Deliverable 5.2) was submitted to the EU at 30 October 2017. It reported on the methodological development of the testing and implementation framework (TIF) for increasing the socio-technical readiness of climate adaptation innovations and assessing their impact on different socio-economic and environmental sectors.

This Testing and Implementation Framework (TIF) was developed by BRIGAID with the aim to fill the observed gap of a lacking internationally accepted framework for assessing the readiness of innovations that reduce disaster risk.

BRIGAID's TIF-Tool – an Excel-based self-assessment of the performance of climate adaptation innovations – forms an important part of BRIGAID's Testing and Implementation Framework. The Tool is designed to help innovators identify possible technical, environmental, sectoral, and societal concerns that their innovations may raise early on – and iteratively throughout the development – so that they may modify their designs and not become locked into those that are less likely to appeal to end users. The TIF-Tool is accompanied by a Guidance document, that is intended to guide climate adaptation innovators through interpreting the results to their self-assessment of the performance of their innovations using BRIGAID's TIF-Tool.

Since its release, the initial versions of the TIF-Tool were applied by innovators in stocktaking cycle 1 and cycle 2, and in a workshop during BRIGAID's half-yearly project meeting in Lisbon (May 2018).

This yielded valuable feedback from innovators and helped to improve the TIF-Tool, resulting in TIF-Tool version 1.3.

The present report (Deliverable 5.4) refers to Deliverable 5.2 'A Testing and Implementation Framework (TIF) for Climate Adaptation Innovations', and provides the updated version of the TIF-Tool (Version 1.3) and the accompanying guidance document (Appendix C in Deliverable 5.2), and reports on innovator feedback from the application of the TIF-Tool in stocktaking cycle 1 and 2 and from the workshop on the application of the TIF-Tool (new Appendix G). The present report (Deliverable 5.4) thus forms an update of BRIGAID's Deliverable 5.2 'A Testing and Implementation Framework (TIF) for Climate Adaptation Innovations' that was submitted at 30 October 2017 to the EU. Deliverable 5.2 is not included, but instead is referred to Deliverable 5.2 and appendices (except for appendix C)

The final and complete version of the 'Testing and Implementation Framework (TIF) for Climate Adaptation Innovations' will be submitted in month 48 by TU Delft. In this final version all updates will be integrated, including updates forthcoming from stocktaking cycle 3 and feedback from e.g. the planned workshop with professionals from water boards.

Report Organization

Deliverable 5.4 'Update of the Testing and Implementation Framework (TIF) for Climate Adaptation Innovations' consist of the following chapters:

1. Introduction (the present chapter).

2. Update Appendix C. Guidelines for Innovators Using the TIF (including the Tabs of the TIF-Tool version 1.3) (Chapter 2)

3. (New) Appendix G. Innovator Feedback Report on the TIF Tool after stocktaking cycle 1 and 2. (Chapter 3)

2 Updated version of Appendix C

- **Guidance Document** (Version 1.3)
- **Tabs of the TIF-Tool** (Version 1.3)

A Test and Implementation Framework (TIF-Tool) for Climate Adaptation Innovations: **Tool Guidance** (Version 1.3; January 2019)

Contents

1. Introduction

2. Technical performance assessment

3. Environmental impacts assessment

4. Sectoral impacts assessment

5. Societal acceptance assessment

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1. Introduction

This document is intended to guide climate adaptation innovators through interpreting the results to their self-assessment of the performance of their innovations using the BRIGAID Test and Implementation Framework (TIF) Tool. The TIF-Tool consists of nineteen (19) questions related to technical design, twenty-one (21) questions related to environmental impacts, twenty-five (25) questions related to sectoral impacts, and twenty-two (22) questions related to societal acceptance. These question must be answered with yes, no, a specification, or n.a. (not applicable) and the answers are converted to a score. The Tool is designed to help innovators identify possible technical, environmental, sectoral, and societal concerns that their innovations may raise early on – and iteratively throughout the development – so that they may modify their designs and not become locked into those that are less likely to appeal to end users. The results and recommendations are summarized in a chart (Figure 1).

Many assessment question may serve as 'food for thought', or as topics to discuss with stakeholders or end-users. The TIF Tool does NOT provide a definitive assessment: it is a 'checklist' designed to help identify potential concerns so that innovators can then choose how - or whether - to respond to them.

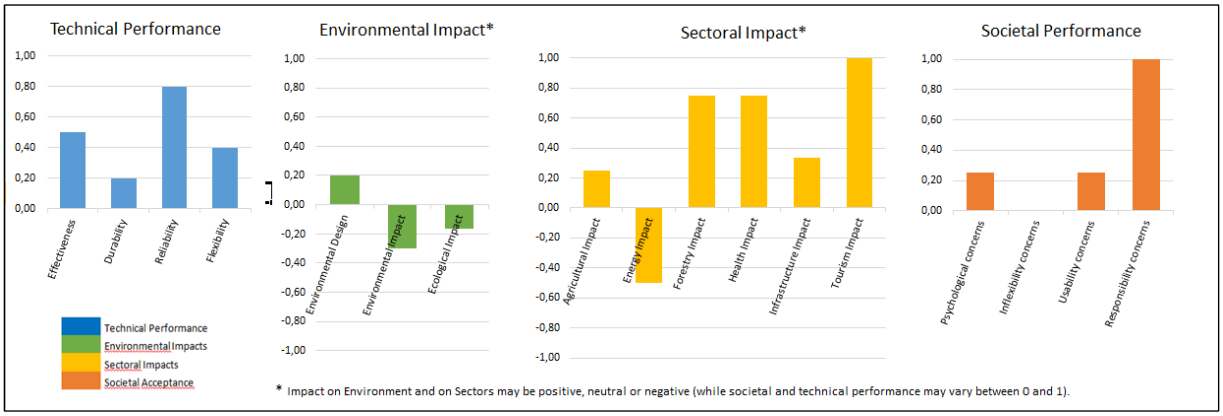

Figure 1: Summary of the results of the TIF-Tool

The Tool is meant to be applied by innovators at three 'stage-gates' – critical points in development at which innovators should pause to identify and address technical, environmental, sectoral and social, concerns. These 'stage-gates' refer to Technology Readiness Levels (TRLs) in the testing framework (see p. 10 and the TIF method document).

'Soft stage-gates' at which to apply the TIF Tool

Stage-gate 1: Apply the TIF Tool prior to validation in a laboratory setting

Stage-gate 2: Apply the TIF Tool prior to testing in an operational setting

Stage-gate 3: Apply the TIF Tool prior to deployment in the real world

The TIF Tool is an Excel spreadsheet with 7 tabs:

1. Navigation/Welcome
2. General information on the innovation's typology
3. Technical performance assessment
4. Environmental impacts assessment
5. Sectoral impacts assessment
6. Societal acceptance assessment
7. Summary of results

The initial navigation page introduces climate adaptation innovators to the layout of the TIF Tool before then presenting them with an innovation typology. This typology will help innovators to clearly identify the types of hazards their innovation is designed to protect against (be it directly or indirectly) and the type of adaptation their innovation is. Some environmental impacts assessment questions may not be applicable to 'social' forms of adaptation. However all technical performance, sectoral impact assessment, and societal acceptance questions are applicable to all adaptations. Some (informational) innovations need to be combined with an additional measure that may have an impact (e.g. prescribed burning). Then the TIF Tool should be applied separately for this structural measure.

Note that the impact of an innovation on the environment and economic sectors can be positive, neutral or negative.

The TIF Tool and this TIF Tool Guidance document are accompaniments to the more detailed TIF Methodology document. Readers who are interested in the theoretical and methodological underpinnings of the Tool and Guidance should refer to the Methodology.

This document proceeds in the following sections by guiding innovators through the process of interpreting the results to their self-assessments of technical performance, environmental impacts, sectoral impacts, and societal acceptance.

2. Technical performance assessment

After completing the technical screening questions (Figure 2), innovators can refer to the interpretations provided in Table 1 below. Using the answers to the questions in the Excel (and the associated scores (range 0 to 1) per indicator), innovators should be able to determine whether adjustments to their design are needed or warranted.

1 Technical Performance Assessment	NB: all questions are applicable for all type of innovations (please fill in an answer for each question)!	
Answer the following questions by writing Yes or No in the corresponding cells.		**Yes or No?**
1	Does the innovation provide significant technical advantage(s) relative to traditional/conventional measures?	No
2	Does your innovation physically prevent a hazard from occurring?	No
3	Does your innovation require combination with other interventions and/or activities in order to reduce risk (e.g, flood warning system in combination with a flood barrier or a fire warning system in combination with controlled burning)?	No
4	Will the innovation require additional testing and/or substantial upgrades when considering future hazard conditions (i.e., considering climate change)?	No
5	Is the lifetime of the innovation limited by climate change? (i.e., will climate change affect the estimated life(time) of the innovation?)	Yes
6	Does the innovation require frequent inspection and maintainence to reach its intended lifetime?	No
7	Are the materials or software needed for maintanence and/or repair easily obtained and can they be integrated by the end-user?	No
8	Is the innovation designed to be used repetitively or continuously operated over its lifetime?	No
9	Can the innovation be operated without repair and/or replacement of components during a hazard event?	No
10	Does the innovation exhibit vulnerabilities during testing and/or demonstration (e.g., structural: sliding or rotation, or technological: errors)?	No
11	Is there a critical component in the innovation's structural or technological design that could lead to catastrophic failure?	No
12	Does your innovation rely on the delivery of services or materials (e.g., structural components, data) outside of your control to be successfully operated during a hazard event?	Yes
13	Does your innovation require the execution of tasks by humans to be successfully operated during a hazard event?	No
14	Can the vulnerability of your innovation to human error be easily reduced through improvements in operational protocols and/or end-user training?	Yes
15	Is the innovation modular (opposite: monolithic) and can it be easily installed or applied at different sites across Europe without adjustment?	No
16	Does the innovation require additional testing and/or substantial upgrades (e.g., new components) if used at different sites across Europe?	Yes
17	Will the size of the market for the innovation (in Europe) will significantly decrease (>50%) due to future hazard conditions (i.e., considering climate change)?	No
18	Have relevant end-users have been identified and involved in formulating design specifications?	Yes
19	Does the design of the innovation deliberately aim for advantages derived from multi-functionality (e.g., reduction of carbon emissions or enhanced recreational activities)?	No

Figure 2: Tab Technical Performance

The questions are intended to assess sets of issues related to the indicators described in the TIF method document: effectiveness, durability, reliability, and exploitability. Depending on how the innovator responds to these questions, their innovation may be more marketable and have a more effective technical design or a design associated with some technical concerns. The table includes information and recommendations on how to alleviate those concerns and improve the performance of their innovation and its technical readiness.

Table 1: Responding to specific areas of technical concern (the numbers refer to the questions in the tab Technical Performance)

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1 If your innovation does not provide significant technical advantage(s) relative to conventional measures, then it is likely to raise concerns about its technical design. Innovators should strive to generate designs which fill an existing gap or fulfil a perceived public (or private) need.

2 If your innovation does not prevent the probability or consequences of a hazard, it may not be able to fully mitigate risk (by itself). Based on the definition of technical effectiveness used by BRIGAID, an innovation which completely reduces risk will always score higher in terms of its technical effectiveness. In these cases, it may be prudent to compare your innovation against similar or conventional technologies to determine whether it provides significant advantages in terms of risk reduction.

3 If your innovation must be implemented or operated in combination with other interventions to reduce risk, it may raise some technical concerns. Innovations which are not stand-alone require that the end-user already have access to other services/processes or the ability to purchase them in combination with your innovation. Furthermore, the ability of your innovation to reduce risk will be dependent on the successful operation and effectiveness of both interventions/processes (see reliability concerns below).

4 If you have not considered future hazard conditions or anticipate that your innovation may require additional testing and/or substantial upgrades to be effective under future climate conditions, this may raise technical concerns. Innovators can refer to the current and future hazard maps provided in the TIF methods document and should consider future conditions in the design of their innovation. Note that some innovations may only be designed to mitigate the intermediate impacts of climate change, in which case the innovation's lifetime will be determined by the time at which the impacts of climate change on the hazard surpass the technical design of the innovation (e.g., when the return probability of a flood exceeds the design height of a structure) (see lifetime concerns below).

5 If the life of your innovation is determined by climate change, this may raise some technical concerns. An innovator should consider the implementation context of their innovation; if an innovation is designed to be a permanent solution, the innovator should strive to design their innovation to withstand the effects of climate change on the relevant hazard.

6 If your innovation requires frequent inspection and maintenance to reach its lifetime, it may raise concerns about the innovation's durability. Frequent inspection and maintenance is typically associated with higher costs over the innovations' lifetime and thus will lower its cost-benefit. It may also raise potential concerns about the innovation's reliability during an event.

7 If the materials or software needed for maintenance or repair of your innovation are difficult to obtain, this is likely to raise durability concerns. Innovators should consider incorporating materials that can be easily (and cost-effectively) obtained in case of emergency maintenance or repair.

8 If your innovation is not designed to be used repetitively and is only single-use, this may raise durability concerns. Innovations which can be used repetitively (or continuously) over their lifetime can be expected to have a higher cost-benefit over their lifetime. Innovators should strive to design innovations which are not single-use (and do not generate waste, see environmental concerns).

9 If your innovation requires repair or replacement of components during the hazard event, this may raise some technical concerns. Innovations which are designed to fully withstand the hazard without replacement will score higher.

10 If your innovation exhibits vulnerabilities during testing, this could lead to very low technical reliability. The innovation should be designed to withstand the hazard and the innovator should provide a level of safety (e.g., in the form of probability of failure or a safety factor) associated with the innovation.

11 If there is a critical component in the design of the innovation that could lead to catastrophic failure, this will raise reliability concerns. Innovators should consider how to minimize or remove the potential for catastrophic failure by optimizing the design of the innovation.

12 If your innovation relies on the delivery of services or materials to be successfully operated during a hazard event, this may raise reliability concerns. Innovators should consider this in the design of their innovation and work with end-users to reduce such vulnerabilities.

13 If your innovation requires on the execution of tasks by humans to be successfully operated during a hazard event, this may raise reliability concerns. Innovators should strive to minimize the potential for failure due to human error (e.g., by optimizing the operation and maintenance protocols or requiring execution by trained experts).

14 If the innovation's vulnerability to human error cannot be easily reduced, this may raise reliability concerns. Innovators should consider how to remove potential for human error in the design of their innovation (for example, by automating processes or removing human decision points).

15 A monolithic innovation raises some concerns as it may be difficult to deploy/build in other locations throughout Europe. Innovations which are modular can more easily be distributed/marketed at all locations where the hazard is present. Furthermore, as in the case of some mobile innovations, some modular innovations can be used by a single end-user at multiple locations during different hazard events, making them more attractive (and flexible) than monolithic innovations.

16 An innovation's exploitability will increase, the more easily it can be adapted to different implementation contexts. If your innovation requires additional testing or substantial upgrades to be marketed or used at different sites in Europe, this may negatively affect its exploitability.

17 If the size of the market for your innovation will be substantially reduced by climate change, this may raise some exploitability concerns. Innovators should consider the impacts of climate change on the size of their market in the design of their innovations.

18 If relevant end-users or implementation contexts have not yet been identified, this may raise some exploitability concerns. Involvement of end-users in formulating design specifications will aid implementation. Therefore, innovators should strive to identify implementation contexts and develop contact to potential end-users during the early stages of the design of their innovation.

19 Multi-functional innovations have arguably more exploitation potential. For example, innovations which have co- or secondary-benefits (e.g., innovations which increase energy production or decrease an end-user's reliance on fossil fuels) or perform a secondary function during non-hazard times (e.g., have recreational value or boost tourism) have higher exploitation potential than those which only perform a single function.

While not all of these issues require the innovator to take action (and some may not be relevant for a given implementation context), they are intended to help increase the innovator's awareness of potential technical concerns. By scoring themselves against conventional measures and other innovations which promise the same or similar benefits, the innovator will gain perspective of how their innovation may perform in the European market in the context of its technical design.

Technical Readiness Level (TRL) scales

Based on the answers to the questions listed in Table 1 above, an innovator may choose to make changes to the original design of the innovation. An adjusted TRL Scale which lists key tasks related to the readiness of climate adaptation innovations has been included in a separate spreadsheet to help guide innovators through R&D. When testing, an innovator should refer to the checklist to assess the technical readiness of their innovation. Note that this TRL Scale assumes that when entering BRIGAID an innovator is at or has already achieved TRL 4 (prototype) and is striving to reach TRL 8 (demonstration) (see Figure 3).

Significant changes to the original design of the innovation, based on the answers to the societal, technical, or environmental questions, or because significant negative impacts are foreseen based on the questions related to sectoral impacts, may require that the innovator returns to TRL 1-3 or an earlier testing phase (e.g., laboratory testing). An innovator should be weary of proceeding too far in the TRL Scale and becoming entrenched before screening their innovation using the TIF Toolbox.

For more detailed guidance related to testing in each phase, innovators are encouraged to refer to the methods document and references included therein.

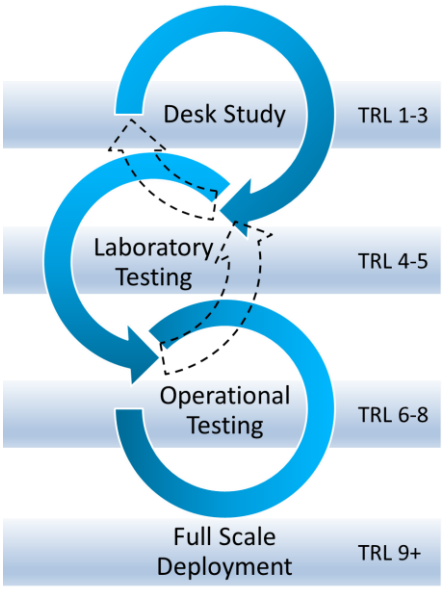


Figure 3: Conceptual model showing the four testing phases based on TRL definitions (see TIF method document).

3. Environmental impacts assessment

Climate adaptation innovations are designed to mitigate safety risks (for people, properties or infrastructure), but can also affect their environment (including nature and ecosystems). A positive impact of an innovation on the environment (such as an increase in nature area, or reduced energy demand) may lead to support for the development, speed up the market uptake and the implementation of your innovation. It may even help to find funding to further develop your innovation. In order to get insight in the potential impact of an innovation, the foreseen impacts has to be compared with the present situation (i.e., reference situation, which may already be altered by previous adaptation measures) and to the business as usual approach over the short and long-term. It is important to note that the effect of climate change and the local, regional, and national impact(s) of an innovation will be highly dependent on the geographic location.
Because adaptations may have negative trade-offs on the environment, the environmental impacts are scored on a scale from -1 to 1.

Direct impacts are those caused by the preparation, construction, or operation of an innovation at a particular location. Indirect impacts are those that occur away from the location of the innovation (in space or in time) as a consequence of the implementation or operation of an innovation. The construction or the operation of an innovation may result in a temporary (short or long term) disturbance of the environment. Some impacts may be reversible with additional efforts when the innovation would be removed. Other impacts on the environment may be permanent (e.g. when some species disappear from a location, they may never return).

If on forehand is clear that an innovation will have significant effects on the environment (e.g. the construction of a dike or a water retention area), or that implementation of innovation will need substantial space (that is for instance, currently designated as nature area), than there is likely a legal requirement for an Environmental Impact Assessment (EIA). For an EIA more advanced analyses than the TIF-Tool is needed. In an EIA the impact of the plan or project must be compared with some alternative solutions. An EIA normally requires a substantial amount of detailed information on several topics (amongst other on species and habitats), supplied and analysed by experts. Information on EU's laws on Environmental Impact Assessment of major projects and of public plans and programs together with other related information can be found on www.ec.europa.eu/environment/eia. Furthermore each EU country provides its own information on national EIA obligations (see national websites on Environmental Impact Assessment).

Regarding the impact on the environment, sustainability forms an important ambition for climate change innovation. Sustainable innovations are not harmful to the environment nor depleting natural resources, and support long-term ecological balance. Sustainability can be described as the endurance of systems and processes. Healthy ecosystems and environments are necessary to the survival of humans and other organisms.

After completing the environmental screening questions (Figure 4), innovators can refer to the interpretations provided in the next section.

3.1	Environmental Design	
3.1.1	Does the innovation deliberately use ecosystems and their services, or mimic or preserve natural processes? (A) Yes (B) No, and the innovation may hinder natural processes or services provided by ecosystems, (C) No, but the innovation does not affect the ecosystems present nor natural processes	A
3.1.2	How does the change in footprint (area) required for implementation on-site compare to conventional measures or the present situation? (A) Increase space required (B) Decrease space required (C) No Impact on space required	A
3.1.3	How does the construction or operation of the innovation affect the quantity of greenhouse gases in the environment (e.g., as CO_2 or CH_4)? (A) Increase (B) Decrease (C) No Impact	A
3.1.4	Is the innovation made from recycled or recycable materials? (A) Yes (B) No, it is made of non-recycable materials (C) Partly	A
3.1.5	Does the innovation include specific design features or components which preserve or enhance ecosystem services? (A) Yes (B) No, and the innovation may hinder natural processes or services provided by ecosystems (C) No, but the innovation does not affect the ecosystems present nor natural processes	A

3.2	Environmental Impact	
3.2.1	How does the innovation impact the quality of surface water? (A) Improve (B) Worsen (C) No Impact	A
3.2.2	How does the innovation impact the quantity of available surface water? (A) Increase (B) Decrease (C) No Impact	C
3.2.3	How does the innovation impact the quality of ground water? (A) Improve (B) Worsen (C) No Impact	A
3.2.4	How does the innovation impact the quantity of available ground water? (A) Increase (B) Decrease (C) No Impact	B
3.2.5	How does the innovation impact the quality of the sea water? (A) Improve (B) Worsen (C) No Impact	B
3.2.6	How does the innovation impact soil quality? (A) Improve (B) Worsen (C) No Impact	B
3.2.7	How does the innovation impact air quality? (A) Improve (B) Worsen (C) No Impact	B
3.2.8	Does the implementation (or construction) of the innovation generate debris? (A) Yes (B) Debris can even be stored or captured by the innovation (C) No	A
3.2.9	Does the implementation (or construction) of the innovation generate noise or vibration? (A) Yes (B) It even dampens noise (C) No	A
3.2.10	How does the innovation impact landscape quality? (A) Improve (B) Worsen (C) No Impact	A

3.3	Ecological Impact	
3.3.1	How does the innovation impact the spatial extent of protected nature area? (A) Increase (B) Decrease (C) No Impact	B
3.3.2	How does the innovation impact the quality of protected habitats? (A) Improve (B) Worsen (C) No Impact	A
3.3.3	How does the innovation impact the number protected species (e.g., birds, vegetation, fish, mammals)? (A) Increase (B) Decrease (C) No Impact	A
3.3.4	How does the innovation impact the spatial extent of non-protected nature area? (A) Increase (B) Decrease (C) No Impact	B
3.3.5	How does the innovation impact the quality of non-protected habitats? (A) Improve (B) Worsen (C) No Impact	B
3.3.6	How does the innovation impact the number non-protected species (e.g., birds, vegetation, fish, mammals)? (A) Increase (B) Decrease (C) No Impact	C

Figure 4: Tab Environmental Impact

Explanation questions on environmental impacts

3.1 Environmental Design

3.1.1 Nature-based Solutions: A special type of innovative adaptation measures (with an increasing interest of e.g. the European Commission) are Nature-based Solutions. They deliberately use ecosystems and the services they provide, and/or natural processes (like water retention, water storage, buffering of floods, wave damping, changing wildfire conditions (e.g. by removing burnable material), changing soil conditions, providing shade etc.) to address societal challenges such as climate change or natural disasters. Nature-based Solutions are often used in conjunction with other types of interventions.

3.1.2 Areal Footprint: the physical implementation of the innovation may require space at its implementation location that is currently used for other purposes. This may result in resistance.

3.1.3 Carbon Footprint: the construction, transportation to its implementation location, and/or application of the innovation may result in additional CO2 emissions compared with the current situation. The use of local materials may reduce transportation, and subsequently the amount of carbon dioxide released. Implementation may be favoured if an innovations forms a sink for carbon dioxide (e.g. because the innovation increases permanent vegetation development that could store carbon dioxide).

3.1.4 Resource Footprint: recycling and recyclability fits in the Circular Economy concept and in the Cradle to Cradle concept. A Circular Economy is a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling. Cradle to Cradle pertains a "closed loop" approach to production processes, where waste forms a resource for production. The innovation is made of recyclable materials.

3.1.5 Footprint on the Services provided by the natural Ecosystem: The natural environment offers besides its intrinsic value, a broad range of benefits for human beings, such as the provision of products (e.g. food, fibres, wood, fresh water, medicines), regulation of temperature, nutrients,

waste, water, and greenhouse gasses, supporting services, such as nutrient cycles and crop pollinations, and providing cultural and amenity values (e.g. recreation, tourism, inspiration, spiritual). These benefits are called ecosystem services. An innovation may affect these ecosystem services provided by the natural environment.

3.2 Environmental Impact

Environmental quality is a set of properties and characteristics of the environment (water, soil and air). It forms a measure of the condition of the environment. In the EU the environmental quality is protected from pollution by several EU and national regulations and standards and it is monitored by governmental agencies. Pollution can be defined as the addition of any substance (solid, liquid, or gas) or any form of energy (such as heat, sound, or radioactivity) to the environment at a rate faster than it can be dispersed, diluted, decomposed, recycled, or stored in some harmless form.

3.2.1 Surface Water Quality: the construction, implementation, and/or application of the innovation may affect aquatic ecosystems, drink water production, health situation, availability of water for irrigation, fish production, tourism, etc. by producing pollutants like nutrients, oil spilling, chemicals, salt, plastics, or an increase in water temperature, etc.

3.2.2 Surface Water Quantity: the construction, implementation, and/or application of the innovation may also affect the water quantity by using water, streamlining extreme discharges, buffer and/or store extreme discharges.

3.2.3 Ground Water Quality: an innovation may affect ground water quality by producing pollutants like nutrients, oil spilling, chemicals, salt, etc.

3.2.4 Ground Water Quantity: an innovation may also affect ground water quantity by using water, affecting the ground water level, retention of freshwater, etc.

3.2.5 Sea Water Quality: the construction, implementation, and application of an innovation may affect sea water quality by releasing pollutants like nutrients, oil spilling, chemicals, plastics, which in return may result in an impact on marine ecosystems, fish production, tourism, health situation, etc.

3.2.6 Soil Quality: an innovation may affect soil properties such as nutrient status, salinity, and water holding capacity. These are important for terrestrial ecosystems, agricultural and forestry production, health situation, etc. Furthermore, soil support buildings and roads.

3.2.7 Air Quality: air quality is important for the health situation, and air pollution can result in diseases, allergic reactions and even deaths. Furthermore, air pollution may affect buildings. An innovation may (temporarily or permanently) produce air pollutants like chemicals, particulates (e.g. dust), biological molecules, etc. (NB Carbon Dioxide is already included in the Carbon Footprint question).

3.2.8 Debris: an innovation may result in debris. Some debris is easily recyclable, while other debris may need further processing or must be stored.

3.2.9 Noise: during construction or implementation, the innovation may result in temporarily noise. However, some innovations may result in permanent noise during application.

3.2.10 Landscape Quality: An innovation may affect the visible features (like hydrological or ecological aspects, settlement patterns, cultural history, scenic characteristics, or land use patterns) of an area of land, its landforms, and how they integrate with natural or other man-made features.

3.3 Ecological Impact

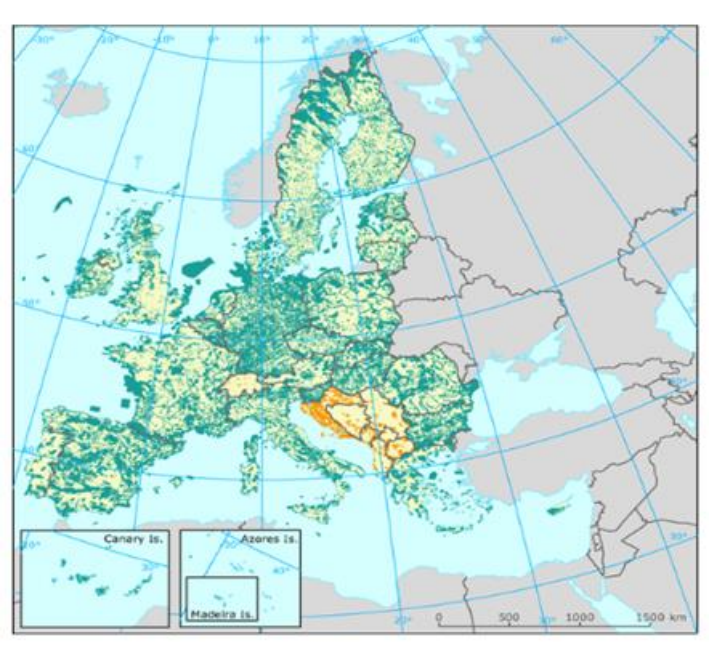
The conservation of biodiversity, restoration of nature, and greening the economy and the society as a whole to make them more sustainable are important ambitions of the EU. 'Green' aspects will certainly favour implementation of the innovation.

3.3.1 Nature Conservation: innovations may result in an impact on the size of protected nature area. Such an innovation will certainly encounter legal resistance, and probably lead to the requirement of detailed ecological analysis and the obligation to compensate the affected nature values by developing a new nature area.

Due to its physical geography and the long history of cultural development, Europe harbours a broad variety in ecosystems (e.g. Cropland and grassland, Woodland and forest, Heathland and shrub, Sparsely vegetated land, Wetlands, Rivers and lakes, Marine, Urban, Mountains, Islands, see http://biodiversity.europa.eu/topics/ecosystems-and-habitats/grasslands).

Several of these areas are designated as EU Natura 2000 sites. Natura 2000 is an EU-wide network of nature protection areas established under the Habitats Directive and Birds Directive. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive and Birds Directive. Water quality is protected by EU's Water Framework Directive. Furthermore, on a national scale areas are designated as nature area, nature reserve, national park, or protected landscape.

Maps and information available on e.g. http://natura2000.eea.europa.eu/# provide a first impression of the nature values present.



3.3.2 Nature Conservation: innovations may result in an impact on the quality of habitats in the protected nature area, and cause a shift from one habitat towards another habitat.

3.3.3 Protected species: Many European wildlife species (birds, vegetation, fish, mammals, other animals) are increasingly in danger. Therefore, the EU aims to protect all species facing particular threats by e.g. the EU Habitats (Habitats Directive 92/43/EEC) and Birds Directive (Directive 2009/147/EC), in which over 1.000 animal and plant species are mentioned. NB: Because of the diversity and complexity of ecosystems, the help of experts may be needed to identify if and which protected species are present at a certain location, and to assess how the innovation may affect these species.

3.3.4 Non-protected nature (size): Not all nature in Europe is protected by international (Natura 2000 area) or national legislation (e.g.as designated nature area, nature reserve, national park, or protected landscape). Implementation of innovations in these areas may expect no legal hurdles forthcoming from nature conservation agreement and less resistance than in protected nature areas. If an innovation would result in an increase of nature, then it will probably meet societal support.

3.3.5 Quality of the non-protected habitats: Ex-ante identified positive co-benefits of the innovations for non-protected habitats could result in a swift implementation of the innovation.

3.3.6 Impact on the number of non-protected species: an increase in the number or the variety of species could result in support from the general public and the government.

4. Sectoral impacts assessment

Climate Adaptation Innovations are designed to directly offset the effects of climate change in socio-economic sectors like agriculture, energy, forestry, health, infrastructure or tourism. However, they may also have (unintended or unforeseen) co-benefits or trade-offs in others. All impacts must be compared with the present situation (i.e., reference situation) and to the business as usual approach over the short and long-term. Because adaptations may have negative trade-offs, the sectoral impacts are scored on a scale from -1 to 1.

Direct impacts are those caused by the preparation, construction, or operation of an innovation at a particular location. Indirect impacts are those that occur away from the location of the innovation (in space or in time) as a consequence of the implementation or operation of an innovation. The construction or the operation of an innovation may result in a temporary (short or long term) disturbance of socio-economic sector. Some impacts may be reversible with additional efforts when the innovation would be removed, while other impacts may be permanent.

It is important to note that the effect of climate change and the local, regional, and national impact(s) of an innovation on the different socio-economic sectors will be highly dependent on the implementation of the innovation at a specific geographic location. Its impact will also depend on the duration and severity of a hazard event together with the exposure, vulnerability and resilience of the socio-economic sector(s) and their components.

4.1	**Agriculture**	
4.1.1	How does the innovation impact the total area available for agricultural production? (A) Increase (B) Decrease (C) No Impact	A
4.1.2	How does the innovation impact agricultural production conditions (e.g., by increasing soil quality or water availability)? (A) Improve (B) Worsen (C) No Impact	A
4.1.3	How does the innovation impact the variety of agricultural products (e.g., crops, dairy, meat, fruit, fish, aquaculture) that can be produced or are available? (A) Increase (B) Decrease (C) No Impact	B
4.1.4	How does the innovation impact the total yield of one or more agricultural products? (A) Increase (B) Decrease (C) No Impact	C
4.2	**Energy**	
4.2.1	How does the innovation impact the energy production capacity (e.g., by generating energy or increasing energy distribution)? (A) Increase (B) Decrease (C) No Impact	B
4.2.2	How does the innovation impact the reliability of energy production (e.g. by improving cooling water conditions for energy plants)? (A) Increase (B) Decrease (C) No Impact	B
4.2.3	How does the innovation impact the efficiency of energy production? (A) Increase (B) Decrease (C) No Impact	B
4.2.4	How does the innovation impact the carbon footprint of the end-user? (A) Increase (B) Decrease (C) No Impact	B
4.3	**Forestry**	
4.3.1	How does the innovation impact the total area available for wood production (including timber and biomass)? (A) Increase (B) Decrease (C) No Impact	A
4.3.2	How does the innovation impact wood production conditions (e.g., by increasing forest resilience or water availability)? (A) Improve (B) Worsen (C) No Impact	A
4.3.3	How does the innovation impact the total area available for non-wood production (including cork, fruit, honey, mushrooms, pastures, game and fishing)? (A) Increase (B) Decrease (C) No Impact	A
4.3.4	How does the innovation impact non-wood production conditions (e.g., by increasing forest resilience or water availability)? (A) Improve (B) Worsen (C) No Impact	C
4.4	**Health**	
4.4.1	How does the innovation impact the number of fatalities in the area exposed to the hazard? (A) Increase (B) Decrease (C) No Impact	B
4.4.2	How does the innovation impact the number of people affected by the hazard in their physical health (i.e., number of people injured)? (A) Increase (B) Decrease (C) No Impact	B
4.4.3	How does the innovation impact the number of people affected by the hazard in their mental/psycho-social health? (A) Increase (B) Decrease (C) No Impact	B
4.4.4	Does the innovation emit or release chemicals or products that are harmful to humans? (A) Yes (B) It can even capture harmful substances (like small particles) (C) No impact on concentration of chemicals or harmful products	C
4.5	**Infrastructure**	
4.5.1	How does the innovation impact the quality of the built environment (I.e., residential, commercial, and industrial)? (A) Improve (B) Worsen (C) No Impact	B
4.5.2	How does the innovation impact the total area available for urban development? (A) Increase (B) Decrease (C) No Impact	A
4.5.3	How does the innovation impact the capacity of existing transportation systems (e.g., roads, railways, waterways, and airports) or create new capacities? (A) Increase (B) Decrease (C) No Impact	A
4.5.4	How does the innovation impact the reliability of existing transportation systems (e.g., roads, railways, waterways, and airports)? (A) Increase (B) Decrease (C) No Impact	B
4.5.5	How does the innovation impact the transport capacity of critical infrastructure networks (e.g., power, water, waste management)? (A) Increase (B) Decrease (C) No Impact	A
4.5.6	How does the innovation impact the reliability of critical infrastructure networks (e.g., power, water, waste management)? (A) Increase (B) Decrease (C) No Impact	A
4.6	**Tourism**	
4.6.1	How does the innovation impact the total area available for recreational activities? (A) Increase (B) Decrease (C) No Impact	A
4.6.2	How does the innovation impact the attractiveness of the area for recreational activities? (A) Increase (B) Decrease (C) No Impact	A
4.6.3	How does the innovation impact the length of the tourist season? (A) Increase (B) Decrease (C) No Impact	A

Figure 5: Tab Sectoral Impact

After completing the sectoral screening questions (Figure 5), innovators can refer to the interpretations provided in the next sections.

4.1 Agriculture

4.1.1 If an innovation needs area that is currently used for agricultural production, then its implementation may lead to resistance among farmers, and implementation could lead to an obligation to compensate the affected landowners.

4.1.2 If your innovation could improve local agricultural production conditions e.g. by increasing freshwater availability, improving the groundwater table, preventing damage by temporal flooding, or increasing the soil quality, then your innovation will probably meet support from farmers.

4.1.3 If your innovation could lead to an increase in the variety of agricultural products that could be produced, then this may result in interest of farmers or consumers for your innovation. However, when new products do require new expertise or additional investments, such interest may be very modest, or result in a demand for agricultural innovation.

4.1.4 If your innovation results in increased yield, e.g. by improving local production conditions, or improving harvest conditions or methods, then your innovation probably will meet support from local farmers.

4.2 Energy

4.2.1 If your innovation generates energy (e.g. a device that harvest wave energy) or sources for energy production (e.g. biofuel), or offers space for energy production (e.g. wind turbines or solar panels), then it probably meet support from the energy sector, the government, and the general public.

4.2.2 Research has shown that climate change may affect power generation by decreasing water availability and increasing ambient air and water temperature, which reduces the efficiency in cooling. If your innovation improves cooling water conditions for energy plants, then it will probably meet support from the energy sector and the government.

4.2.3 If your innovation improves the efficiency of energy production, then it will probably meet support from the energy sector and the government.

4.2.4 The energy sector is the largest contributor to global GHG emissions. If the innovation results in less greenhouse gas emission by the energy sector than in the current situation, or forms a sink for carbon dioxide, then it probably will be meets societal support and support from the energy sector.

4.3 Forestry

4.3.1 If an innovation needs area that is currently used for wood production, then its implementation may lead to concern from the forestry sector, and implementation could lead to an obligation to compensate the affected wood producers.

4.3.2 If your innovation would lead to improved resilience of a forest against climate change (e.g. by improving surface water management conditions, improving the groundwater table, preventing damage by temporal flooding, or increasing the soil quality) then your innovation probably result in support from the forestry sector.

4.3.3 If your innovation cost area that is currently in use for non-wood productions such as cork, fruit, hone, mushrooms, pastures, game, or fish, then it will meet concern from forest owners and users, and implementation could lead to an obligation to compensate the affected non-wood producers.

4.3.4 If your innovation would result in improved production conditions for non-wood products such as cork, fruit, hone, mushrooms, pastures, game, or fish, then your innovation probably result in low resistance or even in support from forest owners and users.

4.4 Health

4.4.1 If your innovation could decrease the potential numbers of fatalities of climate change related hazards (e.g. by reducing the risk of drowning during a flood, by a cooling effect during heat waves, by improving air and or water quality during heat waves), then it will probably be supported by the health sector, the government, and the general public.

4.4.2 If your innovation could reduce the impact of hazards on the physical health of affected people (e.g. by reducing the impacts of floods, by a cooling effect during heat waves, by improving air and or water quality during heat waves), then it will it will probably be supported by the health sector and the general public.

4.4.3 Climate change related hazard may result in stressful conditions for human beings, such as a high night temperature during heat waves (which may impact sleep). If your innovation could reduce the impact of climate related hazards (e.g. by reducing the urban heat effect due to the cooling effect of vegetation, the urban wind pattern, or water bodies) on the mental/psycho-social health of affected people, then it will it will probably not meet resistance by the health sector or the general public.

4.4.4 If your innovation emits or release chemicals or products that are harmful, then this may result in resistance, and it is recommended to adjust the design in order to prevent or reduce the emittance of these chemicals.

4.5 Infrastructure

4.5.1 If the innovation improves the quality of the built environment (e.g. by a urban design that deliberately uses trees to provide shade, or green roofs or walls to cool buildings or to store rainwater, or to develop green water retention areas), then it will probably meet less resistance, or even support from local residents or the local government.

4.5.2 If the innovation needs area that is currently in use for urban development, then it will probably meet resistance from the infrastructural sector, and implementation could lead to the appointment of another area for urban development, or an obligation to compensate the affected stakeholders.

4.5.3 If the innovation does increase existing transportation capacity or create new transportation possibilities (e.g. roads, railways or energy transportation networks integrated in flood defences), then it is likely to meet less resistance, and even receive support from the transportation sector and the government.

4.5.4 If the innovation results in a higher reliability of the existing transportation systems (e.g. by reducing the time that a road or railway is flooded, or by reducing the potential damage by erosion due to flooding to roads and railways), then it will probably meet few resistance, or even support from the general public and the transportation sector.

4.5.5 If an innovation results in a decrease in the power, water or waste management infrastructure, then it may not be accepted, and the innovator is advised to adjust the design.

4.5.6 If an innovation results in a less reliable infrastructure, then the innovator is advised to adjust the design.

4.6 Tourism

4.6.1 If an innovation needs area that is currently used for recreational activities, then it will probably meet resistance, while an innovation that results in more recreational area (e.g. a green water retention area, or water square in the urban area), will probably meet support.

4.6.2 If an innovation improves the recreational attractiveness of an area, e.g. by creating nature area or walking paths, then it will probably not lead to public resistance, and could create opportunities to strengthen or to develop the tourist sector.

4.6.3 If an innovation would lead to an extended tourist season (e.g. by offering new recreation possibilities outside the normal tourist season) then it will probably generate support among the general public and the tourist sector.

5. Societal acceptance assessment

After completing the societal acceptance questions (Figure 6)innovators can use this guidance to interpret their results and identify possible societal acceptance concerns for their innovations. Scores range from 0 to 1.

The questions in the Societal Section 1 are yes or no questions. They test particular issues or sets of issues associated with the themes of issues described in the TIF method document: psychological concerns, inflexibility concerns, usability concerns and responsibility concerns. Depending on how an innovator responds to these questions they will have either given a response associated with higher public concern or a response associated with lower public concern.

	Societal Acceptance assessment NB: all questions are applicable for all type of innovations (please fill in an answer for each question)!	
Answer the following 16 questions by writing Yes or No in the corresponding cells. These questions apply to ALL types of adaptations.		**Yes or No?**
1	Does your innovation use any materials that might be considered unfamiliar (such as nanomaterials or genetically modified materials)?	Yes
2	Will members of the public affected by your innovation be the ones to decide whether or when to use it?	Yes
3	Does your innovation involve visible infrastructure (such as physical barriers) or visible land use changes (such as woodland removal)?	Yes
4	Could the use/deployment of your innovation disrupt daily activities, for example through road closures?	Yes
5	Does your innovation require large amounts of capital investment relative to other adaptations in the sector?	Yes
6	Does your innovation require a long lead time between users placing an order and it becoming operational?	Yes
7	Does your innovation require new infrastructure or significant changes to existing infrastructure?	Yes
8	Does your innovation involve releasing any materials into the environment (such as sprays or coatings)?	Yes
9	Are your potential users likely to have a single mission, for example to protect ecosystems?	Yes
10	Does your innovation take less time to use/deploy than incumbent alternatives (such as sand bags for floods or fire nozzles for wildfires)?	No
11	Would everyday users of your innovation require special training in how to use it?	No
12	Will your organisation provide help and support to users of your innovation?	No
13	Innovations can either reinforce or change users' existing ways of working. Does your innovation reinforce existing ways of working?	No
14	Are the effects of your innovation directly publicly tangible (such as seeing flood defences working or hearing a warning alert system)?	No
15	Adaptations can either be used/deployed permanently or temporarily. Is your innovation deployed permanently?	No
16	Is any personal data associated with the adaptation shared with others, for example other companies? If your innovation uses no personal data, select 'No'	No
17	Is any personal data associated with the adaptation held securely, for example in an encrypted database? If your innovation uses no personal data, select 'Yes'	No
18	Are members of the general public involved in shaping the research, development, demonstration and deployment of your innovation?	Yes
Answer the following 4 questions by writing A, B or C in the corresponding cells.		**A, B or C?**
19	What would your innovation primarily protect (either directly or indirectly)? (A) public infrastructure, (B) private properties and assets, or (C) the environment	A
20	Who would pay for your innovation? (A) government authorities, (B) private companies or (C) local communities	B
21	Who would implement your innovation? (A) government authorities, (B) private companies or (C) local communities	A
22	How would compensation be made in the event of your innovation failing? Through (A) government compensation, (B) project insurance or (C) responsible parties	C

Figure 6: Tab Societal Acceptance

Innovators can now explore specific areas of societal concern by consulting the guidance on answers to each question associated with higher public concern given in Table 2 below. The table includes material and organisational recommendations on how to alleviate those concerns and improve the performance of their innovation and its societal readiness.

Table 2: Responding to specific areas of societal concern

1 If your innovation uses unfamiliar materials (such as nanomaterials or genetically modified materials) it is likely to raise societal concerns. Psychological science shows that unfamiliar materials and novel impacts are associated with higher levels of public concern. Innovators should consider using familiar alternatives to lower societal concerns.

2 To the extent that members of the public affected by your innovation will not be the ones to decide whether or when to use it, it may raise public concerns. Psychological science shows that involuntary exposure and a lack of personal control is associated with higher levels of public concern. Innovators should consider recommending an appropriate level of public control over their innovation to those implementing the innovation to lower societal concerns.

3 If your innovation involves visible infrastructure (such as physical barriers) or visible land use changes (such as woodland removal), psychological science shows that it may raise public concerns. Innovators should consider developing unobtrusive infrastructure and avoid making land use changes near human settlements to lower societal concerns.

4 If the deployment of your innovation could disrupt daily activities, psychological science shows that it is likely to raise public concerns. Innovators should consider designs that work around daily activities to lower societal concerns.

5 If your innovation requires large amounts of capital investment, sociological research shows that it is likely to raise public concerns. Innovators should consider designs that do not require large amounts of capital investment to lower societal concerns.

6 If your innovation requires a long lead time between users placing an order and it becoming operational, sociological research shows that it is likely to raise public concerns. Innovators should consider ways of reducing lead times to lower societal concerns.

7 If your innovation requires new infrastructure or significant changes to existing infrastructure, sociological research shows that it may raise public concerns. Innovators should consider using existing infrastructure and minimising any changes to lower societal concerns.

8 If your innovation involves releasing any materials into the environment (such as sprays or coatings) it is likely to raise public concerns. Sociological research shows that unrecoverable releases and irreversible actions are associated with higher levels of public concern. Innovators should consider designs that do not release materials into the environment to lower societal concerns.

9 If your users are likely to have a single mission, for example to protect ecosystems, sociological research shows that they are likely to raise public concerns about your innovation. Innovators should consider targeting their innovation at users with plural missions or joint ventures between single mission users with different missions to lower societal concerns.

10 If your innovation takes as long or more time to deploy than incumbent alternatives (such as sand bags for floods or fire nozzles for wildfires) it is likely to raise public concerns. Management science shows that longer deployment times and delayed effects are associated with higher levels of public concern. Innovators should consider designs that take less time to deploy than incumbent alternatives to lower societal concerns.

11 If the use of your innovation require special training, management science shows that it is likely to raise public concerns. Innovators should consider designs that are less complex to lower societal concerns.

12 If help and support will not be available to users of your innovation, management science shows that it is likely to raise public concerns. Innovators should consider appropriate ways of providing help and support to users after they have procured your innovation to lower societal concerns.

13 If your innovation disrupts rather than reinforces existing ways of working, management science shows that it is likely to raise public concerns. Innovators should consider designs that minimise changes to existing ways of working to lower societal concerns.

14 If the effects of your innovation are not directly publicly tangible (such as seeing flood defences working or hearing a warning system) it is likely to raise public concerns. Management science and psychological research shows that unseen benefits, unobservable effects and non-awareness of exposure is associated with higher levels of public concern. Innovators should consider designs that make the benefits of their innovation tangible.

15 If your innovation is deployed temporarily, management science shows that it is likely to raise public concerns. Innovators should consider designs that make their innovation a more permanent solution to lower societal concerns.

16 If personal data associated with the adaptation is shared with others, for example other companies, it is likely to raise public concerns. Management science shows that sharing personal data is associated with higher levels of public concern. Innovators should not share personal data with any third parties without first obtaining explicit prior consent.

17 If personal data associated with the adaptation is not held securely, it is likely to raise public concerns. Management science shows that insecurely held personal data is associated with higher levels of public concern. Innovators should hold personal data securely, for example in an encrypted database.

18 If members of the public are not involved in shaping the research, development, demonstration and deployment of your innovation it is likely to raise public concerns. Science studies and sociological research show that exclusion and closure to criticism are associated with higher levels of public concern. Innovators should consider ways of including members of the public and being open to criticism.

The questions in Societal Section 2 are multiple choice questions. They test particular issues associated with the sociocultural theme of issues described in the TIF method document. Depending on how an innovator responds to these questions they will have given a response that indicates their innovation is best suited to ‘technocratic’, ‘techno-optimistic’ or ‘techno-sceptical’ implementation contexts.

Innovators might now locate the intended implementation context of their innovation in a triangular space to help them think about where they are likely to meet societal support and where they are likely to meet societal resistance (see Figure 7).

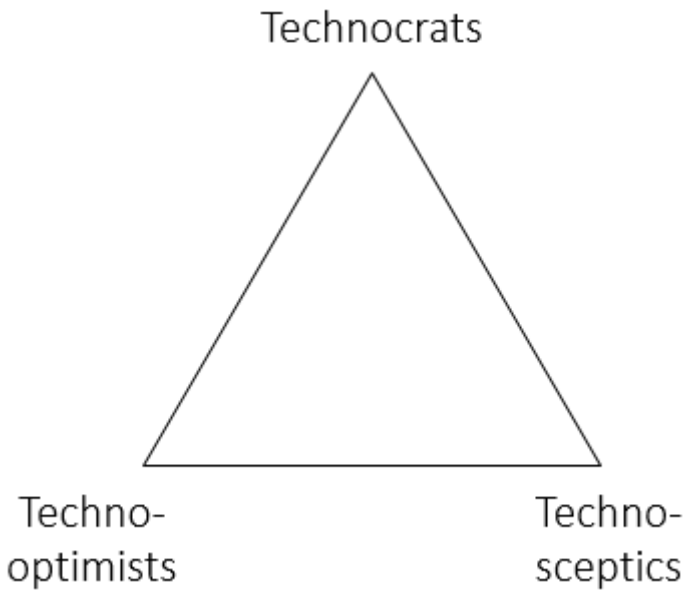


Figure 7: A space for matching technology characteristics with implementation contexts

Technocratic, techno-optimistic and techno-sceptical implementation contexts each hold unique preferences for particular sets of technology characteristics:

- Technocrats tend to prefer long-lasting, tried-and tested and large-scale technologies with a traditional aesthetic.
- Techno-optimists tend to prefer rapidly replaceable, cutting-edge and profit-maximising technologies with a striking aesthetic.
- Techno-sceptics tend to prefer environmentally benign, low-tech and small-scale technologies with a natural aesthetic.

Innovators might now also locate the technology characteristics of their innovation in the triangular preference space to help them think about where they are likely to meet societal acceptance and rejection. The aim of this exercise is to match preferred technologies with preferred implementation contexts:

- Bureaucracy enabling, long-lasting, tried-and tested and large-scale technologies are best used to protect public infrastructure, paid for and implemented by government authorities and held liable through government compensation.
- Individually enabling, rapidly replaceable, cutting-edge and profit-maximising technologies are best used to protect private properties, paid for and implemented by private companies and held liable through project insurance.
- Community enabling, environmentally benign, low-tech and small-scale technologies are best used to protect the environment, paid for and implemented by local communities and held liable through responsibly parties.

If the intended implementation context and set of technology characteristics do not match, innovators are likely to encounter societal resistances. For example, the implementation context may be technocratic, but the technology characteristics are preferred by techno-optimists. Innovators should consider changing either their implementation context or set of technology characteristics to make sure they match. If the implementation context and set of technology characteristics do match, innovators are likely to encounter societal acceptance where they match and resistances where they do not. For example, a technocratic implementation context and

technocratic set of technology characteristics is likely to meet societal resistances from techno-optimists and techno-sceptics.

If innovators require a deeper analysis of the societal acceptance issues surrounding their innovation they will need to employ social scientific experts to directly engage the public using one or more established methods for eliciting public perceptions and preferences. A selection of these methods are described in the TIF method document, together with their typical strengths and weaknesses.

TABs of the TIF-Tool Version 1.3

Welcome Tab:

TIF-Tool Version 1.3

For more information on BRIGAID, see http://brigaid.eu/

TIF-Tool: A Testing and Implementation Framework (TIF) for Climate Adaptation Innovations

The BRIGAID Test and Implementation Framework Tool (TIF Tool) is designed to help climate adaptation innovators identify possible societal, technical, environmental and sectoral concerns that their innovations may raise early on – and iteratively throughout the development – so that they may modify their designs and not become locked into those that are less likely to appeal to end users. The TIF Tool is a self-assessment tool and should be applied in the least at three 'stage-gates' – critical points in development at which innovators should pause to identify and address social, technical, environmental and sectoral concerns. By raising a range of societal, technical, environmental and sectoral issues known to be of concern (but which might not all be applicable for your innovation) the TIF Tool supports interaction and communication between innovators and end-users about these concerns and subsequently helps to identify how those concerns might be addressed.

Many assessment question may serve as 'food for thought', or as topics to discuss with stakeholders or end-users. The TIF Tool does NOT provide a definitive assessment: it is a 'checklist' designed to help identify potential concerns so that innovators can then choose how - or whether - to respond to them.

- Stage-gate 1: Apply the TIF Tool prior to validation in a laboratory setting
- Stage-gate 2: Apply the TIF Tool prior to testing in an operational setting
- Stage-gate 3: Apply the TIF Tool prior to deployment in the real world

The TIF Tool consists of 6 tabs (+current tab), each dedicated to assessing a different aspect of climate adaptation innovations' overall performance and readiness:
- General questions about the type of innovation
- Technical performance – questions designed to identify areas of possible technical concern over an innovation
- Environmental impacts – questions designed to identify areas of possible environmental concern over an innovation
- Sectoral impacts – questions designed to identify areas of possible sectoral concern over an innovation
- Societal acceptance – questions designed to identify areas of possible societal concern over an innovation
- Summary of results – the overall performance of an innovation and a break-down of performance against societal, technical, environmental and sectoral questions and specific issues

The TIF Tool Guidance document provides information on how innovators should interpret the results of their self-assessment (TIF Tool results) and suggestions how to modify their designs.
The TIF Tool and the TIF Tool Guidance document are accompaniments to the more detailed TIF Methodology document. Readers who are interested in the theoretical and methodological underpinnings of the Tool and Guidance should refer to the Methodology.

For help on the separate issues of business development and market readiness, readers should refer to the BRIGAID Market Analysis Framework (MAF+).

Tab: General Questions:

Please fill in the name of your innovation:			
Developed by (fill in your name):			
Please fill in the date:			
Adaptation Innovation are designed to reduce climate related hazards. This could be:			
	Type of Hazard		***Description***
	Floods	Coastal Flood	A flood resulting from high sea water levels and wave impact that exceed flood protection levels; these hydraulic conditions are generally caused by storm surges.
		River Flood	A flood resulting from high-river discharges (that exceed flood protection levels); the high-river discharges are caused by heavy precipitation and/or snow melt in the river basin.
		Flash Flood	A flash flood is a rapid flooding of low-lying areas (e.g. rivers, dry lakes), and often the result of rapid run-off due to heavy precipitation on saturated soil or dry soil that has poor absorption ability; the collected run-off then forms a larger volume, or even a fast flowing waterfront.
	Droughts		A sustained and extensive occurrence of below average water availability, whether atmospheric, surface, or ground water caused by climate variability. Droughts can result in water scarcity when the drought conditions cause long-term imbalances between water availability and demands.
	Extreme Weather	Heat wave	A prolonged period of excessively hot, and sometimes also humid, weather relative to normal climate patterns of a certain region.
		Wildfire	An uncontrolled fire in an area of combustible vegetation that occurs in the countryside. Fire ignition and spread are both enhanced by cumulated drought, high temperature, low relative humidity and the presence of wind.
		Storm	Natural events characterized by strong winds, often in combination with heavy precipitation (e.g., heavy rainfall, hail, etc.).
		Heavy Precipitation	Rainfall events that result in (1) (urban) floods due to exceedance of drainage capacity, and (2) flash floods, defined as rapid flooding of low lying areas, generally within a few hours after a heavy rainfall events such as thunderstorms.
			Type of Hazard / Fill in Subtype (if any)
1	Please indicate, which type of climate related hazard would be reduced by your innovation?		**……** / **…..**

There are different types of adaptations, including:			
	Structural/ physical	Engineered and built environment	Sea walls and coastal protection structures; flood levees and culverts; water storage and pump storage; sewage works; improved drainage; beach nourishment; flood and cyclone shelters; building codes; storm and waste water management; transport and road infrastructure adaptation; floating houses; adjusting power plants and electricity grids
		Technological	New crop and animal varieties; genetic techniques; traditional technologies and methods; efficient irrigation; water saving technologies including rainwater harvesting; conservation agriculture; food storage and preservation facilities; early warning and response systems; building insulation; mechanical and passive cooling; renewable energy technologies; second-generation biofuels
		Ecosystem-based	Ecological restoration including wetland and floodplain conservation and restoration; increasing biological diversity; afforestation and reforestation; conservation and replanting mangrove forest; wildfire reduction and prescribed fire; green infrastructure (e.g., shade trees, green roofs); controlling overfishing; fisheries co-management; assisted migration or managed translocation; ecological corridors; ex situ conservation and seed banks; community-based natural resource management; adaptive land use management
		Services	Social safety nets and social protection; food banks and distribution of food surplus; municipal services including water and sanitation; vaccination programs; essential public health services including reproductive health services and enhanced emergency medical services; international trade
	Social	Educational	Awareness raising and integrating into education; gender equity in education; extension services; sharing local and traditional knowledge including integrating into adaptation planning; participatory action research and social learning; community surveys; knowledge-sharing and learning platforms; international conferences and research networks; communication through media
		Informational	Hazard and vulnerability mapping; systematic monitoring and remote sensing; climate services including improved forecasts; downscaling climate scenarios; longitudinal data sets; integrating indigenous climate observations; community-based adaptation plans including community-driven slum upgrading and participatory scenario development
		Behavioral	Accommodation; household preparation and evacuation planning; retreat and migration, which has its own implications for human health and human security; soil and water conservation; livelihood diversification; changing livestock and aquaculture practices; crop-switching; changing cropping practices, patterns, and planting dates; sylvicultural options; reliance on social networks
2	Which type of adaptation is your innovation?		Please select Type **Technological**

Tab: Technical Performance

	1 Technical Performance Assessment NB: all questions are applicable for all type of innovations (please fill in an answer for each question)!	
	Answer the following questions by writing Yes or No in the corresponding cells.	**Yes or No?**
1	Does the innovation provide significant technical advantage(s) relative to traditional/conventional measures?	
2	Does your innovation physically prevent a hazard from occurring?	
3	Does your innovation require combination with other interventions and/or activities in order to reduce risk (e.g, flood warning system in combination with a flood barrier or a fire warning system in combination with controlled burning)?	
4	Will the innovation require additional testing and/or substantial upgrades when considering future hazard conditions (i.e., considering climate change)?	
5	Is the lifetime of the innovation limited by climate change? (i.e., will climate change affect the estimated life(time) of the innovation?)	
6	Does the innovation require frequent inspection and maintainence to reach its intended lifetime?	
7	Are the materials or software needed for maintanence and/or repair easily obtained and can they be integrated by the end-user?	
8	Is the innovation designed to be used repetitively or continuously operated over its lifetime?	
9	Can the innovation be operated without repair and/or replacement of components during a hazard event?	
10	Does the innovation exhibit vulnerabilities during testing and/or demonstration (e.g., structural: sliding or rotation, or technological: errors)?	
11	Is there a critical component in the innovation's structural or technological design that could lead to catastrophic failure?	
12	Does your innovation rely on the delivery of services or materials (e.g., structural components, data) outside of your control to be successfully operated during a hazard event?	
13	Does your innovation require the execution of tasks by humans to be successfully operated during a hazard event?	
14	Can the vulnerability of your innovation to human error be easily reduced through improvements in operational protocols and/or end-user training?	
15	Is the innovation modular (opposite: monolithic) and can it be easily installed or applied at different sites across Europe without adjustment?	
16	Does the innovation require additional testing and/or substantial upgrades (e.g., new components) if used at different sites across Europe?	
17	Will the size of the market for the innovation (in Europe) will significantly decrease (>50%) due to future hazard conditions (i.e., considering climate change)?	
18	Have relevant end-users have been identified and involved in formulating design specifications?	
19	Does the design of the innovation deliberately aim for advantages derived from multi-functionality (e.g., reduction of carbon emissions or enhanced recreational activities)?	

Refer to the accompanying TIF Tool guidance document for detailed help on interpretating your results from these technical design questions and to the TIF method document for detailed background on the theory and method that underpins them.

Tab: Environmental Impact

2 Environmental Impact Assessment

Answer the following questions by choosing A, B, C, or n/a in the corresponding cells. Please fill in 'no impact' when an (informational) innovation has no ***direct*** *impact. some (informational) innovations need to be combined with a structural measure that may have an impact (then apply seperately the TIF Tool for this structural measure).*

NB*:* **A, B, C,** or n/a (not applicable) **?**

3.1	**Environmental Design**
3.1.1	Does the innovation deliberately use ecosystems and their services, or mimic or preserve natural processes? (A) Yes (B) No, and the innovation may hinder natural processes or services provided by ecosystems, (C) No, but the innovation does not affect the ecosystems present nor natural processes
3.1.2	How does the change in footprint (area) required for implementation on-site compare to conventional measures or the present situation? (A) Increase space required (B) Decrease space required (C) No Impact on space required
3.1.3	How does the construction or operation of the innovation affect the quantity of greenhouse gases in the environment (e.g., as CO_2 or CH_4)? (A) Increase (B) Decrease (C) No Impact
3.1.4	Is the innovation made from recycled or recycable materials? (A) Yes (B) No, it is made of non-recycable materials (C) Partly
3.1.5	Does the innovation include specific design features or components which preserve or enhance ecosystem services? (A) Yes (B) No, and the innovation may hinder natural processes or services provided by ecosystems (C) No, but the innovation does not affect the ecosystems present nor natural processes

3.2	**Environmental Impact**
3.2.1	How does the innovation impact the quality of surface water? (A) Improve (B) Worsen (C) No Impact
3.2.2	How does the innovation impact the quantity of available surface water? (A) Increase (B) Decrease (C) No Impact
3.2.3	How does the innovation impact the quality of ground water? (A) Improve (B) Worsen (C) No Impact
3.2.4	How does the innovation impact the quantity of available ground water? (A) Increase (B) Decrease (C) No Impact
3.2.5	How does the innovation impact the quality of the sea water? (A) Improve (B) Worsen (C) No Impact
3.2.6	How does the innovation impact soil quality? (A) Improve (B) Worsen (C) No Impact
3.2.7	How does the innovation impact air quality? (A) Improve (B) Worsen (C) No Impact
3.2.8	Does the implementation (or construction) of the innovation generate debris? (A) Yes (B) Debris can even be stored or captured by the innovation (C) No
3.2.9	Does the implementation (or construction) of the innovation generate noise or vibration? (A) Yes (B) It even dampens noise (C) No
3.2.10	How does the innovation impact landscape quality? (A) Improve (B) Worsen (C) No Impact

3.3	**Ecological Impact**
3.3.1	How does the innovation impact the spatial extent of protected nature area? (A) Increase (B) Decrease (C) No Impact
3.3.2	How does the innovation impact the quality of protected habitats? (A) Improve (B) Worsen (C) No Impact
3.3.3	How does the innovation impact the number protected species (e.g., birds, vegetation, fish, mammals)? (A) Increase (B) Decrease (C) No Impact
3.3.4	How does the innovation impact the spatial extent of non-protected nature area? (A) Increase (B) Decrease (C) No Impact
3.3.5	How does the innovation impact the quality of non-protected habitats? (A) Improve (B) Worsen (C) No Impact
3.3.6	How does the innovation impact the number non-protected species (e.g., birds, vegetation, fish, mammals)? (A) Increase (B) Decrease (C) No Impact

Refer to the accompanying TIF Tool guidance document for detailed help on interpretating your results from these environmental design questions and to the TIF method document for detailed background on the theory and method that underpins them.

Tab: Sectoral Impact

3 Sectoral Impact Assessment

Answer the following questions by choosing A, B, or C in the corresponding cells. Please fill in 'no impact' when e.g. an (informational) innovation has no ***direct*** *impact.* **A, B or C?**
NB*: some (informational) innovations need to be combined with a structural measure that may have an impact (then apply seperately the TIF Tool for this structural measure).*

4.1	**Agriculture**
4.1.1	How does the innovation impact the total area available for agricultural production? (A) Increase (B) Decrease (C) No Impact
4.1.2	How does the innovation impact agricultural production conditions (e.g., by increasing soil quality or water availability)? (A) Improve (B) Worsen (C) No Impact
4.1.3	How does the innovation impact the variety of agricultural products (e.g., crops, dairy, meat, fruit, fish, aquaculture) that can be produced or are available? (A) Increase (B) Decrease (C) No Impact
4.1.4	How does the innovation impact the total yield of one or more agricultural products? (A) Increase (B) Decrease (C) No Impact

4.2	**Energy**
4.2.1	How does the innovation impact the energy production capacity (e.g., by generating energy or increasing energy distribution)? (A) Increase (B) Decrease (C) No Impact
4.2.2	How does the innovation impact the reliability of energy production (e.g. by improving cooling water conditions for energy plants)? (A) Increase (B) Decrease (C) No Impact
4.2.3	How does the innovation impact the efficiency of energy production? (A) Increase (B) Decrease (C) No Impact
4.2.4	How does the innovation impact the carbon footprint of the end-user? (A) Increase (B) Decrease (C) No Impact

4.3	**Forestry**
4.3.1	How does the innovation impact the total area available for wood production (including timber and biomass)? (A) Increase (B) Decrease (C) No Impact
4.3.2	How does the innovation impact wood production conditions (e.g., by increasing forest resilience or water availability)? (A) Improve (B) Worsen (C) No Impact
4.3.3	How does the innovation impact the total area available for non-wood production (including cork, fruit, honey, mushrooms, pastures, game and fishing)? (A) Increase (B) Decrease (C) No Impact
4.3.4	How does the innovation impact non-wood production conditions (e.g., by increasing forest resilience or water availability)? (A) Improve (B) Worsen (C) No Impact

4.4	**Health**
4.4.1	How does the innovation impact the number of fatalities in the area exposed to the hazard? (A) Increase (B) Decrease (C) No Impact
4.4.2	How does the innovation impact the number of people affected by the hazard in their physical health (i.e., number of people injured)? (A) Increase (B) Decrease (C) No Impact
4.4.3	How does the innovation impact the number of people affected by the hazard in their mental/psycho-social health? (A) Increase (B) Decrease (C) No Impact
4.4.4	Does the innovation emit or release chemicals or products that are harmful to humans? (A) Yes (B) It can even capture harmful substances (like small particles) (C) No impact on concentration of chemicals or harmful products

4.5	Infrastructure
4.5.1	How does the innovation impact the quality of the built environment (I.e., residential, commercial, and industrial)? (A) Improve (B) Worsen (C) No Impact
4.5.2	How does the innovation impact the total area available for urban development? (A) Increase (B) Decrease (C) No Impact
4.5.3	How does the innovation impact the capacity of existing transportation systems (e.g., roads, railways, waterways, and airports) or create new capacities? (A) Increase (B) Decrease (C) No Impact
4.5.4	How does the innovation impact the reliability of existing transportation systems (e.g., roads, railways, waterways, and airports)? (A) Increase (B) Decrease (C) No Impact
4.5.5	How does the innovation impact the transport capacity of critical infrastructure networks (e.g., power, water, waste management)? (A) Increase (B) Decrease (C) No Impact
4.5.6	How does the innovation impact the reliability of critical infrastructure networks (e.g., power, water, waste management)? (A) Increase (B) Decrease (C) No Impact

4.6	Tourism
4.6.1	How does the innovation impact the total area available for recreational activities? (A) Increase (B) Decrease (C) No Impact
4.6.2	How does the innovation impact the attractiveness of the area for recreational activities? (A) Increase (B) Decrease (C) No Impact
4.6.3	How does the innovation impact the length of the tourist season? (A) Increase (B) Decrease (C) No Impact

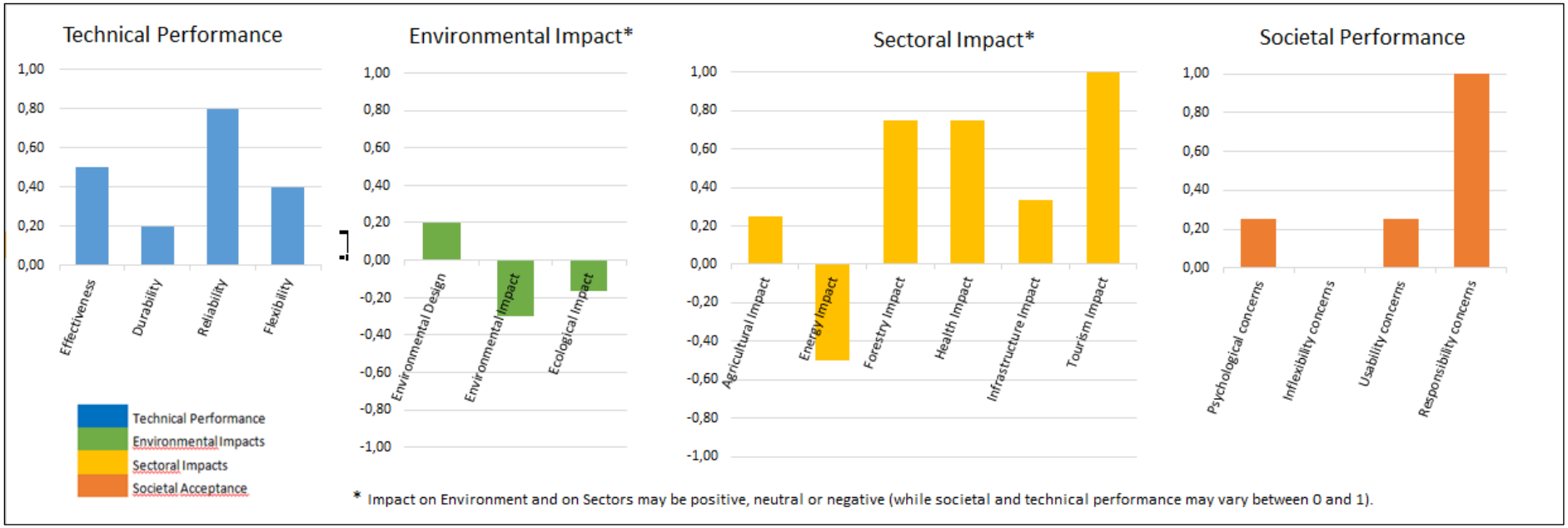
Refer to the TIF method document for detailed background on the theory and method that underpins the questions related to sectoral impacts.

Tab: Societal Acceptance

4	**Societal Acceptance assessment** NB: all questions are applicable for all type of innovations (please fill in an answer for each question)!	
Answer the following 16 questions by writing Yes or No in the corresponding cells. These questions apply to ALL types of adaptations.		**Yes or No?**
1	Does your innovation use any materials that might be considered unfamiliar (such as nanomaterials or genetically modified materials)?	
2	Will members of the public affected by your innovation be the ones to decide whether or when to use it?	
3	Does your innovation involve visible infrastructure (such as physical barriers) or visible land use changes (such as woodland removal)?	
4	Could the use/deployment of your innovation disrupt daily activities, for example through road closures?	
5	Does your innovation require large amounts of capital investment relative to other adaptations in the sector?	
6	Does your innovation require a long lead time between users placing an order and it becoming operational?	
7	Does your innovation require new infrastructure or significant changes to existing infrastructure?	
8	Does your innovation involve releasing any materials into the environment (such as sprays or coatings)?	
9	Are your potential users likely to have a single mission, for example to protect ecosystems?	
10	Does your innovation take less time to use/deploy than incumbent alternatives (such as sand bags for floods or fire nozzles for wildfires)?	
11	Would everyday users of your innovation require special training in how to use it?	
12	Will your organisation provide help and support to users of your innovation?	
13	Innovations can either reinforce or change users' existing ways of working. Does your innovation reinforce existing ways of working?	
14	Are the effects of your innovation directly publicly tangible (such as seeing flood defences working or hearing a warning alert system)?	
15	Adaptations can either be used/deployed permanently or temporarily. Is your innovation deployed permanently?	
16	Is any personal data associated with the adaptation shared with others, for example other companies? If your innovation uses no personal data, select 'No'	
17	Is any personal data associated with the adaptation held securely, for example in an encrypted database? If your innovation uses no personal data, select 'Yes'	
18	Are members of the general public involved in shaping the research, development, demonstration and deployment of your innovation?	
Answer the following 4 questions by writing A, B or C in the corresponding cells.		**A, B or C?**
19	What would your innovation primarily protect (either directly or indirectly)? (A) public infrastructure, (B) private properties and assets, or (C) the environment	
20	Who would pay for your innovation? (A) government authorities, (B) private companies or (C) local communities	
21	Who would implement your innovation? (A) government authorities, (B) private companies or (C) local communities	
22	How would compensation be made in the event of your innovation failing? Through (A) government compensation, (B) project insurance or (C) responsible parties	

Refer to the accompanying TIF Tool guidance document for detailed help on interpretating your results from these societal testing questions and to the TIF method document for detailed background on the theory and method that underpins them.

Tab: Summary of Results



The table belowsummarizes the results of the TIF screening.

1	**Your innovation raises**	**many**	**technical concerns overall, having scored**	**9**	**out of a possible**	**19**	**and is**	**far**	**from/to being ready in terms of its technical design.**
1	Your innovation raises	some	concerns related to its technical effectiveness, having scored	3	out of a possible	4	and is	close	from/to being ready/effective in terms of its technical design.
1	Your innovation raises	many	concerns related to its durability, having scored	1	out of a possible	5	and is	far	from/to being ready/effective in terms of its technical design.
1	Your innovation raises	some	concerns related to its reliability, having scored	3	out of a possible	5	and is	close	from/to being ready/effective in terms of its technical design.
1	Your innovation raises	many	concerns related to its flexibility, having scored	2	out of a possible	5	and is	far	from/to being ready/effective in terms of its technical design.
2	**Your innovation raises**	**several**	**environmental concerns overall, having scored**	**-3**	**on**	**21**	**criteria,**	**and is far from being ready**	**in terms of its environmental design.**
2	Your innovation raises	some concerns,	related to its Environmental Design having scored	1	on	5	criteria. Your innovation may have	a positive impact	on the environment.
2	Your innovation raises	several concerns,	related to its Environmental Impact, having scored	-3	on	10	criteria. Your innovation is may have a	a negative impact	on the environment.
2	Your innovation raises	several concerns,	related to its Ecological Impact, having scored	-1	on	6	criteria. Your innovation is may have a	a negative impact	on the environment.
3	**Sectoral Impacts**								
3	Your innovation raises	few concerns,	related to **Agricultural Impacts**, having scored a total of	1	on	4	criteria. Your innovation may have	a positive impact	impact on the **Agricultural Sector**.
3	Your innovation raises	few concerns,	related to **Energy Impacts**, having scored a total of	2	on	4	criteria. Your innovation may have	a positive impact	impact on the **Energy Sector**.
3	Your innovation raises	few concerns,	related to **Forestry Impacts**, having scored a total of	3	on	4	criteria. Your innovation may have	a positive impact	impact on the **Forestry Sector**.
3	Your innovation raises	few concerns,	related to **Health Impacts**, having scored a total of	3	on	4	criteria. Your innovation may have	a positive impact	impact on the **Health Sector**.
4	Your innovation raises	few concerns,	related to **Infrastructure Impacts**, having scored a total of	2	on	6	criteria. Your innovation may have	a positive impact	impact on the **Infrastructure Sector**.
4	Your innovation raises	no concerns,	related to **Tourism Impacts**, having scored a total of	3	on	3	criteria. Your innovation may have	a positive impact	impact on the **Tourism Sector**.
4	**Your innovation raises**	**many**	**societal concerns overall, having scored**	**4**	**out of a possible**	**18**	**and is**	**far**	**from/to societal readiness.**
4	Your innovation raises	many	psychological concerns, having scored	1	out of a possible	4	and is	far	from/to societal readiness.
4	Your innovation raises	many	inflexibility concerns, having scored	0	out of a possible	5	and is	far	from/to societal readiness.
4	Your innovation raises	many	usability concerns, having scored	2	out of a possible	8	and is	far	from/to societal readiness.
4	Your innovation raises	few	responsibility concerns, having scored	1	out of a possible	1	and is	close	from/to societal readiness.

Refer to the accompanying TIF Tool guidance document for detailed help on interpretating your results from these testing questions and to the TIF method document for detailed background on the theory and method that underpins them.

3 Appendix G

Practice-oriented validation of the TIF-Tool after stocktaking cycle 1 and 2

3.1 Background

BRIGAID Test and Implementation Framework Tool (TIF-Tool) is based on a broad range of scientific knowledge and is developed in close collaboration with climate adaptation innovators and end-users. The purpose of the TIF-Tool (the Excel based self-assessment tool and the accompanying guidance document) is to help innovators to make sure that climate adaptation innovations are addressing early on all sorts of technical, environmental, sectoral, and societal concerns that their innovations may raise– and iteratively throughout the development – so that they may modify their design and not become locked into those that are less likely to appeal to end users. This document reports on the practice-oriented validation of the BRIGAID Test and Implementation Framework Tool (TIF-Tool). It describes the steps in the development of the TIF-Tool and how the collected feedback from the application of the TIF-Tool in stocktaking cycle 1 and 2 and from the workshop on the application of the TIF-Tool was used to adjust the TIF-Tool to support the innovators.

3.2 Preparation phase - TIF-Tool V0 (version 0)

During the so-called ‘Frontrunner-Workshop’ at BRIGAID’s projectmeeting in November 2016 pre-liminary ideas about the various tools to support the implementation of adaptation innovations were discussed with a selected group of BRIGAID’s consortium innovators.

Here it was expressed that climate adaptation innovators especially need a tool that is easy to use without expert assistance and that provides an impression of all sorts of concerns that different decions makers (including policy makers) may have when choosing innovations. The information about the innovation’s performance and impact must be clear and also useful for communication about the innovation. Furthermore the tool had to be usable for different types of innovations and not time-consuming.

Based on these requirements the initial version of BRIGAID’s TIF-Tool (the Excel based self-assessment tool and the accompanying guidance document) was developed (version 0). Before this initial version was launched and presented to innovators in cycle 1, we asked feedback from a selected group of some 10 innovators (BRIGAID ‘Frontrunners’ consortium partners) and decision makers (potential end-users) for the fine-tuning of the first concept. The purpose of gathering feedback was to ensure that (1) the tool is usable by different innovators (who will use the TIF-Tool to identify concerns and develop test plans) without expert assistance and (2) it addresses the sorts of concerns that different decisions makers (including policy makers) may have when choosing innovations. We invited the participants to inform us whether the TIF-Tool was easy to understand and navigate, on the phrasing of the questions, whether the tool was helpful in developing a BRIGAID test plan and whether there was anything missing that decision and policy makers might like to know when making decisions about which climate adaptations to adopt.

We received this feedback on the Excel based self-assessment tool and the accompanying guidance document via a series of telephone interviews and written responses (see Appendix E in Deliverable 5.2). This feedback was used to improve the initial version (version 0), resulting in TIF-Tool version 1 (BRIGAID's Deliverable 5.1, April 2017 and BRIGAID's Deliverable 5.2, October 2017).

3.3 TIF-Tool V1 (version 1)

3.3.1 Stocktaking cycle 1

BRIGAID's TIF-Tool Version 1 was introduced in cycle 1 of the stock-taking process by the leaders of WP 2 (Floods), 3 (Droughts) and 4 (Extreme Weather) to the innovations of consortium partners (see Table 3-1). These consortium partners were invited by the leaders of WP 2, 3 and 4 to apply the TIF-Tool (version 1) on their innovation and to report on their experiences and to include the results of the application of the TIF-Tool (version 1) in their testplan. BRIGAID's 'Frontrunner' innovators had already experience with the application of TIF-Tool version 0.

Table 0-1 Selected innovations cycle 1

	Innovation	Innovator
Innovations from Consortium Partners		
1	eEM-DAT	UCL
2	OBREC	University of Bologna
3	MyFloodRiskProfile	HKV Consultants
4	Flip-Flap Dam	Spectrum Construct SRL
5	ThirdEye: Flying Sensors for Drought and Disease	FutureWater
6	Water + Furrow Diker	S.Q. AQUAPROIECT S.A.
7	InfoSequia	FutureWater
8	GM4W: Water vapour GNSS monitoring & heavy rain nowcasting	GReD srl
9	AEWMS: Active Eco-Wildfire Management System	GIFF Lda
10	FireAd _ Fire Risk Monitor Advisor	Centro de Ecologia Aplicada "prof. Baeta Neves"
Innovations from non-consortium partners (stocktaking)		
1	SCAN	Sumaqua
2	EVAPO-CONTROL	ARANA WM
3	Water from Heaven	Water Innovation Consulting
4	ARIEL	BALAM Ingenieria de Sistemas
5	HYDROVENTIV	Le PRIEURE
6	TubeBarrier	TubeBarrier

This rendered very useful feedback from real-life innovators, via the leaders of WP 2-4. The remarks related to:

- Applicability of some question to all types of innovations. In particular for so-called 'Informational' innovations (such as hazard and vulnerability mapping and systematic monitoring and remote sensing) some questions seem at first sight less applicable.

- The TIF Tool seems a bit biased to structural innovations.
- Many 'Informational' innovations are no direct intervention in reducing impact, and they need to be combined with a structural measure that may have a direct impact.
- Some answers in the societal part of the TIF Tool seem not to match the characteristics of the innovation. E.g. Land use changes necessary to implement a particular structure could have co-benefits (and not only trade-offs).
- In some cases there are more answers possible, depending on the situation. E.g. what the innovation protects, depends on the location (e.g. is there public infrastructure or are private properties present).
- The technology characteristics (in the 'Societal' sheet) depend on the context.
- Presentation of the summary of the results: are negative values possible for 'Environmental' and 'Sectoral' impacts?
- Quantification of the results of the self-assessment (errors in the Excel formulas).
- A drop down menu would be helpful to fill in the answers.

3.3.2 Workshop on the application of the TIF Tool and feedback from WP2-4 breakout session, BRIGAID's Lisbon meeting (April 2018)

As a next step, during BRIGAID's project meeting in Lisbon, a dedicated workshop (19/04/2018) was organized as a pilot with the aim to learn from the application of the TIF-Tool on an innovation (which was in this case the Prescribed Burning Tool). This workshop was attendant by some 30 of BRIGAID's participants (both innovators and end-users). Furthermore, during the WP2-4 breakout session it was discussed how the TIF-Tool has helped innovators. This yielded important insights:

- A joint application of the TIF-Tool on an innovation facilitates a lively discussion on the benefits, co-benefits and trade-offs of the innovation.
- Different people may come with different answers, so there is some subjectivity (however the aim of the TIF-Tool is to help sharpen the ideas about the own innovation).
- The value of the TIF-Tool is that it serves as 'food for thought' for both innovators and end-users.
- Although, the TIF-Tool is meant as a self-assessment, some questions may be difficult to answer without help of experts.
- Innovators may tend to give favourable answers, and try to avoid outcomes that indicate that their innovation may raise some concerns (or are far from readiness).
- An indication by the TIF-Tool that an innovation may raise (some) concern, or is far from readiness, could result in some resistance of innovators against the outcome of the TIF-Tool assessment.

- The TIF-Tool does NOT provide a definitive assessment: it is a 'checklist' designed to help identify potential concerns so that innovators can then choose how - or whether - to respond to them.
- Several question could help to identify import topics for further discussion with stakeholders or end-users.
- The sectoral questions could recognise the ‘decision maker sector’ as a distinct sector with its own set of questions.
- Several questions in the technical and societal part seem at first sight not applicable for all innovations, and the TIF-Tool could invite the innovator to explain why a question is not applicable (and re-consider the applicability of the question).
- The TIF-Tool presents a summary of the assessment result, and it would be helpful to provide an explanation on the scoring and suggestions how to proceed.
- TIF-Tool should refer for help on the separate issues of business development and market readiness, to the BRIGAID Market Analysis Framework (MAF+).
- The TIF-Tool could form a part of a broader ‘BRIGAID toolkit’, which includes the TRL Tool, TIF-Tool, MAF+, other tools (e.g. a sheet that could calculate costs and benefits).
- How to reach innovators outside the BRIGAID project? (Within BRIGAID the TIF-Tool is presented within the stocktaking process).
- It would be useful to provide some examples of application of the TIF-Tool.

3.3.3 Adjustments to the TIF-Tool V1 (resulting in version 1.2)

The feedback from Stocktaking Cycle 1 and the workshop on the TIF Tool was used to improve the version 1 of the TIF-Tool, resulting in TIF-Tool version 1.2. In particular a ‘General’ sheet was included which asks information about the innovator, type of hazard as well as the type of innovation, and provides at the same time (necessary) background information about BRIGAID’s categorisation of hazards and innovations.

In the ‘Welcome’ sheet is stressed that many assessment question may serve as 'food for thought', or as topics to discuss with stakeholders or end-users. The TIF Tool does NOT provide a definitive assessment: it is a 'checklist' designed to help identify potential concerns so that innovators can then choose how - or whether - to respond to them.

The ‘Welcome’ sheet now also refers to BRIGAID’s website, and to BRIGAID Market Analysis Framework (MAF+) for help on the separate issues of business development and market readiness.

In all sheets a drop down menu was inserted for the answers, and the answers were marked in red (to make it more clear).

Several questions were rephrased, some Excel formulas adjusted, and n.a. (not applicable) was added as an answer to several questions.

Furthermore, the ‘Environmental’ and ‘Sectoral’ impact sheets now inform innovators to opt for 'no impact' when an (informational) innovation has no direct impact, and that some

(informational) innovations need to be combined with a structural measure that may have an impact (for which the TIF Tool should be applied separately).

Finally, now it is indicated (in relation to the graphical summary of the 'Innovation Design Assessment') that the impact on 'Environment' and on 'Sectors' may be positive, neutral or negative (while societal and technical performance may vary between 0 and 1).

3.4 TIF-Tool V1.2 (version 1.2)

3.4.1 Stocktaking cycle 1 and 2

TIF-Tool V1.2 was then re-presented to consortium innovators and introduced to non-consortium innovators in cycle 1 (see Table 3-1) of the stock-taking process by the leaders of WP 2-5. All innovators were asked to include the results of the TIF-Tool in their test reports. These results are presented in (the appendices of) Deliverable 2.2 'Test results of cycle 1; Report on initial test results'.

Furthermore the TIF-Tool V1.2 was introduced to all selected innovations in cycle 2 (see Table 3-2) by the leaders of WP2-5. All innovators were asked to include the results of the TIF-Tool V1.2 in their test results (see Deliveable 2.4, 'Test results of cycle 2 innovations').

Table 0-2 Selected innovations cycle 2

	Innovation	Innovator
Innovations from Consortium Partners		
1	Application Framework with Drone system	RINA Consulting
2	Action plan in case of dike failure	Aquaproiect S.A.
3	Toolkit Method	Thetis S.p.A.
4	MyFloodRisk (for business)	HKV Consultants
5	URBRAIN	UTCB
6	Nature-sourced desalination using halophyte-zeolite wetlands	MIGAL - Galilee Research Institute
7	New growing system for food vertical farming	RINA Consulting
Innovations from non-consortium partners (stocktaking)		
1	BlueBloq / Micro Urban Wetlands (MUW)	Field Factors
2	Paint your city green!	Jan Lauwers & partners
3	Multiflexmeter	Waterschap Scheldestromen
4a	Recycle - Porous and Permeable Pavement Block	Favaro1
5	The Mobile Natural Biological System	Ayala Water & Ecology
6	Self-erecting flood protection system	University of Kaiserslautern
7a	Ecological Water Management	Ecological Water Management (consortium)
8	Mole - An underground soil moisture sensor connected to the cloud	IDESIO

We asked feedback from the innovators in cycle 1 and 2, and received feedback via a series of (skype) interviews (6 innovators), via meetings during the Cartagena project meeting (2 innovators and 3 WP leaders) and via email (1 innovator).

This also yielded some additional valuable feedback from innovators:

- The TIF-Tool helps to consider a broad range of aspects in the further development and decisions about steps towards implementation.
- The TIF Tool is easy to understand, even without the guidance document at hand.
- Some minor textual issues.
- Especially the graphical summary is very helpful for innovators, because it provides an easy to understand indication of the technical performance, environmental and sectoral impacts, and societal performance and relates to the techical-scientific background of most innovators.
- The results of the TIF-Tool are helpful in composing a brief report about important performance indicators and impacts of th innovation.
- The graphical summary could be presented more prominently.
- Although it is clearly indicated in the graphical summary, the difference between the range of technical and societal performance (0 ... 1) and environmental and sectoral impact (-1 ,,, +1) is confusing.
- Several indicators match with the ambitions (design criteria) of the NBS innovation, and it is good to notice that the results of the TIF-Tool perfectly reflect these design criteria.
- The TIF-Tool (the Excel-based self-assessment of the performance of climate adaptation innovations) is especially helpful for innovations in TRL 1-3. If there is already a pilot of an innovation (TRL-6), then more detailed background information is required (provided by experts).
- In cycle 2 the TIF-Tool was presented to the (non-BRIGAID partners) innovators in the final stage of testing. However, it might be more beneficial for innovators to apply the TIF-Tool in an earlier stage of the testing process.

3.4.2 Adjustments to the TIF-Tool V1.2 (resulting in version 1.3)

The feedback on TIF-Tool V1.2 from Stocktaking Cycle 1 and 2 was used to improve version 1.2 of the TIF-Tool, resulting in TIF-Tool version 1.3.

Next to a few minor textual adjustments, the main adjustment is a central position of the graphical summary in the sumary tab.

Furthermore the graphical results of the technical performance, environmental impact, sectoral impact and societal performance are now presented with their own scale bar to indicate more clear the difference in range.

3.5 TIF-Tool V1.3 (version 1.3)

TIF-Tool V1.3 will be presented to all innovators in cycle 3 (see Table 3-3) of the stock-taking process by the leaders of WP 2-5.

Table 3-3 Selected innovations cycle 3

	Innovation	Innovator
Innovations from Consortium Partners		
1	AUDIMOD	ICATALIST
2	Irriframe - Acquacampus	UNIBO & Consorzio CER
3	PAS-WATER	ICATALIST
4	FlooDrought	Technical University of Civil Engineering Bucharest
Innovations from non-consortium partners (stocktaking)		
1.	Leaf.skin	Singulargreen
2.	ALMA raingarden	Storm Aqua AS
3.	Natural water retention through restoration of the sponge function of drained soils	Wetlands International
4.	Fire Free Fibres Blankets	Al-Geosystem
5.	RichWater	BioAzul
6.	Flood, planting at Erzeni river	POLIS UNIVERSITY

Like in the previous cycles, all innovators will be asked to include the results of the TIF-Tool V1.3 in their test reports.

Feedback from the innovators in cycle 3 will be used for the final version of the TIF-Tool.

Furthermore TIF-Tool V1.3 will be tested in amongst others a dedicated workshop for water managers (scheduled in February 2019 in Delft). The experiences from this workshop will be used for the final version of the TIF-Tool.

4 Outlook TIF-Tool

Because the TIF-Tool was recognized by BRIGAID's board members as well as by the EU reviewers as a promising tool to support climate adaptation innovators, it was agreed to explore avenues to further develop an open-access web-based version of the TIF-Tool.

Following the suggestion of the EU reviewers to consider the TIF-Tool as an adaptation innovation itself, the idea was raised to apply BRIGAID's MAF+ Tool (the Business Development Exercise) on the TIF-Tool.

In September 2018 a meeting was organized between one of the co-developers of the TIF-Tool (Jantsje van Loon-Steensma, TU Delft) and the developers of the MAF+ (Gerardo Anzaldua and Hugh McDonald, Ecologic Institute). In preparation for this meeting, an account was set up for the TIF-Tool. The initial questions of the MAF+ exercise immediately revealed the differences in goal between BRIGAID's TIF-Tool and other climate adaptation innovations. The TIF-Tool was developed as a free, and easy accessible tool, and not to make profit. Therefore, many questions of the MAF+ seemed not applicable. Moreover, the application of the MAF+ excercise would require a substantial investment of time (e.g. to elaborate a comprehensive bench-mark analysis).

During BRIGAID's meeting in October 2018 the present co-developers of the TIF-Tool (TU Delft, University of Oxford, Universite Catholique de Louvain, Instituto Superior Agronomia, Icre8, Bureau Veritas) agreed that the TIF-Tool was developed as a free, and easy accessible tool, and that TU Delft should took the lead in the further development of an open-access web-based version of the TIF-Tool. This could possible imply the application of the MAF+ Tool.

As a next step, the web-based version of the TIF-Tool could form a part of a broader 'BRIGAID Toolkit', which includes the TRL-Tool, TIF-Tool, MAF+, other tools (e.g. a sheet that could calculate costs and benefits). Further agreements have to be made about hosting and maintenance of such a BRIGAID Toolkit.

The potential of BRIGAID's tools (including the TIF-Tool) is currently explored with various stakeholders, such as water boards and Climate KIC.