

Executive
summary
**Green
Technology
Book 2022**



Climate change impacts are here. And they are here in force. In 2022 alone, several tragic records were broken and the trend toward more frequent, extreme weather events becomes increasingly apparent with every year that passes. Adaptation is a necessity. Despite decades-long warnings and increasingly desperate calls for action, the world has not yet been able to mitigate climate change. At the current pace of action, it is unrealistic to keep global warming below the 1.5°C that the 2015 Paris Agreement is aiming at under best circumstances.

The role of technology in climate change adaptation

Climate change adaptation aims to increase resilience to climate impacts and reduce vulnerability. Climate change impacts can be difficult to predict and their effects take many forms. It is not only a question of protecting ourselves against extreme events. It is also a matter of adapting to the gradual incremental changes likely to change life from how it is for the majority of us. Climate impacts affect how we grow crops, rear livestock, use water, live with the sea, plan our cities and much more. Also, because many natural ecosystems are under threat, they will need our active support if they are to avoid collapse and widespread species extinction averted. While every country is facing climate change impacts, many developing countries are particularly vulnerable. This could be because like the least developed countries they have only limited means with which to respond. Or it could be because of their geographical setting, which is the case for some small island states. Moreover, as many developing countries were never and are not major CO₂ emitters, actions to mitigate climate impacts may be far less relevant in their case than adaptation measures.

Green innovation and technology have solutions to offer. However, it is not a matter of relying on quick fixes and scaling up of a few major breakthrough solutions. It is instead a matter of developing and deploying thousands of solutions at all levels of sophistication. But it would also be wrong to believe that innovation and technology can solve everything. They cannot. Technology is no substitute for a broad range of fundamental and necessary changes to the way we produce and consume.

In this first edition of the *Green Technology Book* – a new WIPO Flagship publication – we aim to demonstrate that a wealth of innovation and technologies aimed at adaptation is not only being developed but currently available. We look specifically at the major sectors of agriculture and forestry, water and coastal areas, and cities. By showing tangible examples of technologies, we hope that this may inspire others to discover and develop solutions to their own challenges. We have chosen to showcase more than 200 technologies but many more exist which to our knowledge are not inferior to the ones included here. Many more solutions can be found in the WIPO GREEN Database of needs and technologies. Solution providers can freely upload to the database, making it a continually expanding source of innovation, technology and solutions.

Adaptation technologies are available but not always accessible

Although there are many technology-based solutions available, they are not being deployed fast enough to meet the multiple climate change challenges. Adaptation technologies are generally behind mitigation technologies in terms of policy support and funding. However, adaptation is gaining traction. Several funding and support institutions specifically target adaptation. The private sector is also coming onboard, as more ways of assessing the returns to and impact from adaptation investment are developed. One sector seeing a remarkable investment growth is

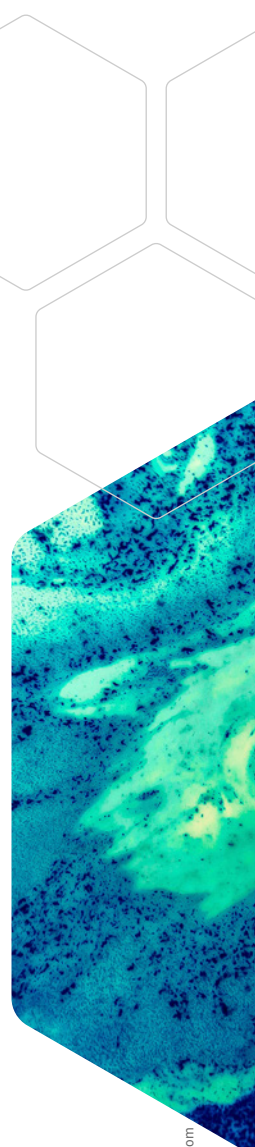


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AgTech. Many countries have also prepared and are now implementing specific adaptation plans. An increasing portion of climate funds is being allocated to adaptation, although still outweighed by mitigation funding. It should also be noted that many of the technologies classified as adaptation technologies also have mitigation aspects, bridging the well-established dichotomy between adaptation and mitigation. Nature-based solutions, where natural processes are utilized or reinforced in order to, for example, protect against floodwaters are gaining ground. Many of those fit under the term “no-regret” solutions providing benefits independent of whether the climate change impacts for which they were designed actually happened as predicted.

A small number of developed countries dominate the innovation space for adaptation technologies, at least when analyzed through patents. Transfer of adaptation technologies to developing countries is happening but at a level well below that of mitigation. This is not so surprising given the often highly advanced technologies being developed for greenhouse gas emissions reduction compared to the very diverse and often less sophisticated solutions needed in adaptation. However, this is not in itself an expression of unwillingness. And what is more, innovation in adaptation technology is growing.

Solutions are created within an innovation ecosystem dependent on many underlying factors. These factors span education, market size and sophistication, and the rule of law. The innovation ecosystem provides the conditions under which an inventor can develop, finance, publicize, market, protect and benefit from an innovation. Intellectual property right is a cornerstone of the innovation ecosystem. And it is through the patenting system that a huge amount of innovation information is made accessible. Technology knowledge can be searched for in several public patent databases. This enables the authorized use of an invention in countries where a patent has been granted, free use in countries where a patent has not been granted, and further development into new patentable inventions.

Thematic areas of the *Green Technology Book*

In this publication, we have focused on three main areas where climate change impacts will be highly significant, namely agriculture and forestry, water and coastal areas, and cities. We have searched for examples of innovation that can provide solutions. They are presented here in order to show what is possible and what can be done.

Technologies are divided into three groups

- Proven technologies which have been around for some time and are well tested;
- Frontier technologies which are new, less well-tested but available; and
- Horizon technologies which are near-future solutions expected on the market within the foreseeable future.

Climate-smart agriculture and forestry

Agriculture and forestry are already heavily influenced by climate change. This manifests itself in changes to cropping season length, higher temperatures and less water, as well as floods, soil salinity and the creation of conditions conducive to pest spread.

In response to these risks, significant developments are taking place in relation to optimized and sophisticated practices. They include using remote and in-field sensing data to provide a detailed understanding of the condition and needs of plants and animals. This information can then direct

various machinery to for example dispense an exact dosage of herbicide or water. This reduces the potentially harmful use of such products, saves resources and helps optimize production in a changing environment. Many of these technologies are best suited to larger operations able to access capital for investment in equipment. However, other advanced technologies may not need such large investments. For example, using almost omnipresent mobile devices, advanced data and control technologies can be made relevant in far smaller and poorer contexts. Moreover, simple improvements in techniques can have a significant effect. For example, by saving on water farmers can reduce their vulnerability to climate change impacts. Many of the practices and technologies that come under the broad term *climate-smart agriculture* benefit both mitigation and adaptation alike. Modifying plants and animals to better cope with a changing climate is another active innovation area. But one which, depending on the methods applied, may carry with it the controversy associated with genetic modification.

Water preservation and coastal protection

Water is fundamental to life. Climate change causes too much or too little. For coastal communities, rising sea levels, violent storms and floods, as well as salt water intrusion, are an increasingly common risk. But so is more acidic and warmer oceans, and this calls for strengthened and innovative approaches to marine ecosystem conservation.

Many important innovations can help save water, as well as monitor quality and the state of water reserves. Remote and in-field sensors play an important role in directing other technologies, for example to regulate water use. Improved rainwater harvesting systems and water storage tanks can maintain supply during dry spells. In some countries, an increasing demand for massive water desalination plants is driving innovation toward higher efficiency and lower costs. Water treatment and advanced control of distribution networks combines several innovative technologies to realize impressive water savings. The need for protection against too much water arriving all at once has prompted significant innovation in flood barriers, nature-based stormwater storage and early warning systems. Coastal zones are particularly vulnerable to climate change. As they are often densely populated and important economic zones, the impacts can be far reaching. Advanced modelling of water and sediment movements helps determine what is the most appropriate protection measure, be it beach nourishment, dikes or other hard and soft protection structures. Here also nature-based solutions such as restoring mangrove forests and coral and other reef types can be no-regret solutions with widespread benefits for people and marine ecosystems.

Climate-adapted cities and urban planning

Extreme weather events in recent years have made it abundantly clear that cities and their populations are highly vulnerable to climate change. New thinking – not least new innovation – is required. Heatwaves, heavy rainfall, floods, storms and rising sea levels have already exacted a toll on populations and impacted city budgets.

Advances in urban planning may provide some solutions. For example, incorporating green infrastructure like stormwater drainage and temporarily transforming underground parking and road networks into reservoirs can reduce a city's vulnerability toward heavy rainfall. New materials and green building design can help mitigate heatwave impacts and reduce the heat island effect found in most cities. Many options exist for greening the cityscape. These can help increase surface water infiltration, reduce heat, provide shade and even produce food.

The global progress of adaptation technologies

Searching for solutions from a variety of sources has taught us some important lessons and it is these that inform the following recommendations.

It is clear that the need for adaptation is not confined to developing countries. Climate change adaptation is needed the world over. But the urgency and the diverse solutions required in developing countries is pronounced. A lot of adaptation is directed there already. But often solutions originating in developing countries are less visible when searching through public and globally available channels. This does not mean that innovation is not taking place. Rather, greater visibility is necessary for adaptation solutions originating in developing countries, not least with the aim of transferring solutions between developing countries and the rest of the world.

Supporting the innovation ecosystem is important. It is important not only for innovation creation, but also for receiving, adopting, adapting and developing it further. Supporting the innovation ecosystem pretty much comes down to nurturing all the many factors that enable people's imagination and creativity to flourish and supporting them in developing their ideas into workable and possibly marketable solutions.

Planning for adaptation is complex. Adaptation has highly diverse needs with many unknowns or uncertainties. Therefore a thorough analysis of the risks, costs and benefits before an initiative is undertaken is crucial in order to avoid maladaptation. Using and improving already mainstreamed safeguarding tools such as Environmental and Social Impact Assessments may be a way forward.

Solutions whether simple or sophisticated are required. In many settings, cheap and simple techniques may at first appear the most suitable and feasible. But highly advanced technologies such as satellite imagery and advanced sensor data can through mobile devices make the difference between being prepared or losing everything. They can also help track the development and impacts of climate events in close to real-time.

The *Green Technology Book* is meant to inspire everyone who needs a solution to a climate change challenge. It may also be a valuable source of inspiration for other related needs. We hope it will. We plan this to be an expanding publication with a new edition added every year. We also want to make the WIPO GREEN Database of needs and green technologies an innovation anchor point. One which will grow alongside the publication every time a user uploads a new solution. This will help make even more innovative solutions known to the general public, experts and lay people alike.



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