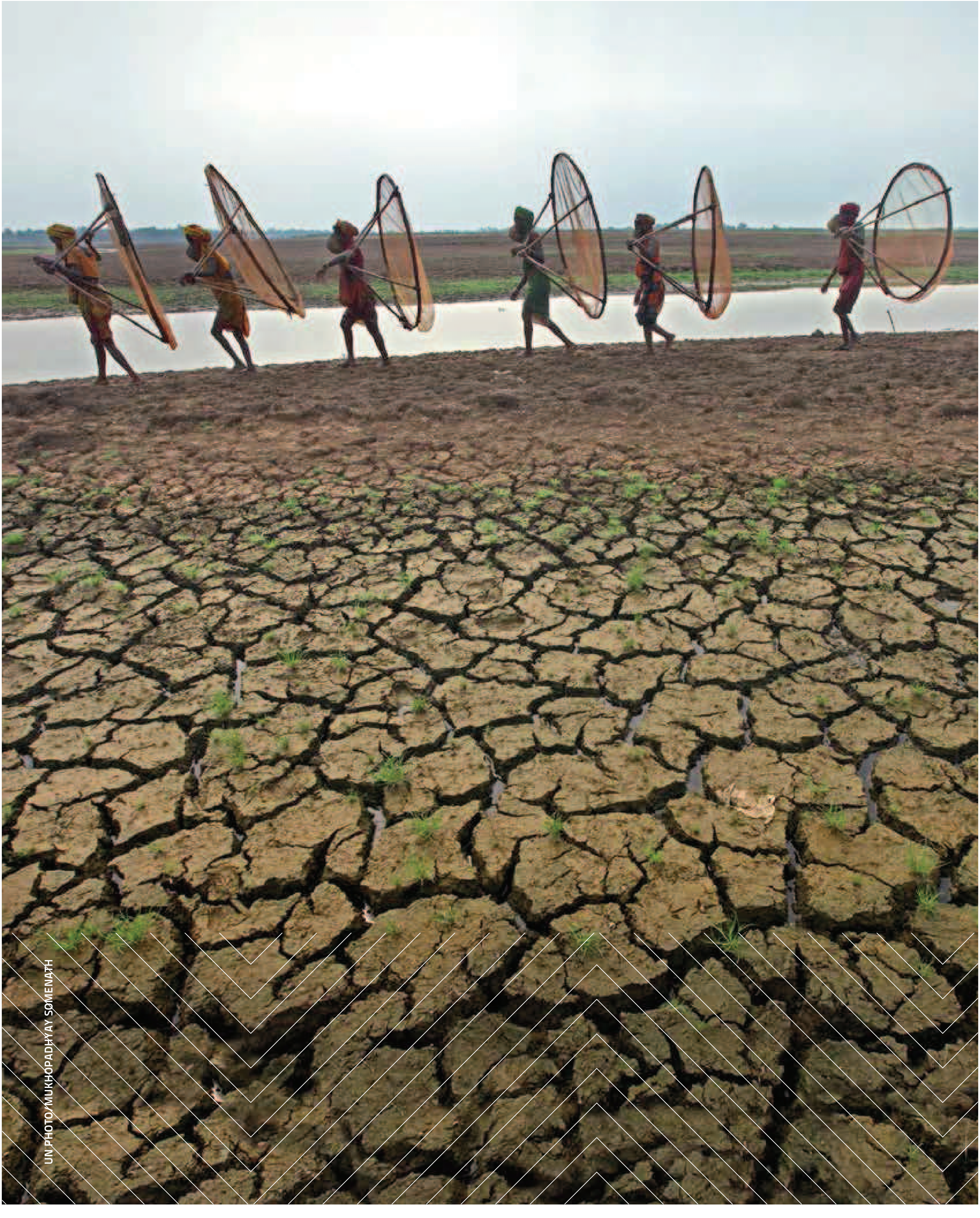

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2

DROUGHT – THE FORGOTTEN DISASTER

CHAPTER 2 DROUGHT – THE FORGOTTEN DISASTER

"Before when we planted corn, it rained regularly.
Now, there isn't enough rain so we have to water and so it costs more money."

Farmer, Dak Lak, Viet Nam[1]

Drought is one of the region's most devastating natural disasters. But it is a slow and silent killer, and therefore often forgotten. Compared with earthquakes, tsunamis, typhoons and floods, drought is a gradual phenomenon – and the devastation it causes is indirect, by steadily reducing supplies of water and food. Combatting drought requires constant vigilance, combining high-tech monitoring with local information and knowledge – and determined efforts to protect ecosystems and livelihoods.

In the early part of the 20th century, millions of people in Asia and the Pacific died from drought and billions more were affected. Since 1970, across Asia and the Pacific drought has claimed far fewer lives at 5,700 people, but has still affected more than 1.6 billion people and cost more than $53 billion in damage.[2] But these are likely to be underestimates. The impacts of drought are difficult to delineate: a drought can reach over vast areas of land, often crossing country borders. It can also be hard to determine when it starts and finishes, and since the damage is indirect it is thus difficult to capture the full costs.

In Asia and the Pacific drought can take on distinctive forms. Elsewhere in the world, drought is typically experienced as a long period of low rainfall, resulting in dry, cracked earth, severe crop loss, dying livestock and famine. Asia and the Pacific has similar disasters but it also has different, shorter forms – during severe winters, for example, or even during monsoons. For these reasons, and because drought appears less dramatic, the impacts are generally not well recorded and receive less attention from the media, policymakers and politicians.

Drought has significant impacts on many sectors, including fish and aquaculture, forestry, and industry. This chapter focuses, however, on agricultural drought – when there is not enough soil moisture to support crop production or fodder for livestock. Asia and the Pacific is a very diverse region, and each country experiences agricultural drought in different ways. In general however, there are four main types of drought:

- *Prolonged periods of low rainfall* – Less than the long-term average rainfall. This is prevalent in semi-arid and arid regions and countries such as Australia, India, parts of China, the Islamic Republic of Iran, and countries of Central Asia, though also in some small island developing States.
- *Irregularities in the monsoon season* – A late start or early finish to the monsoon period, or a dry spell at a key time of the monsoon cropping season. This can have a devastating impact on agriculture. Most countries of South and South-East Asia are affected by this type

of drought. Since these events may be brief and localized, they often go unrecorded, even though they may occur annually.

- *Reduced snowmelt or glacial runoff* – A number of countries rely heavily on water from mountain glaciers and snowmelt. A year with limited snow will affect water resources later during the growing season. This affects Afghanistan, parts of China and India and countries in Central and South Asia.
- *Winter drought and dzud* – A *dzud* is a combination of events leading to inadequate pasture or fodder for livestock. This might, for example, result from a summer drought followed by a severe winter with heavy snow and low temperatures. Mongolia is particularly exposed. Other countries can also suffer during the winter from unusually low precipitation or low temperatures that damage winter crops.

Individual countries can also experience multiple types of drought. They might, for example, have an unpredictable monsoon season followed by a winter with below average precipitation. Likewise, countries can experience multiple disasters in different regions at the same time, such as flooding in one and drought in another.

DROUGHT AND DEVELOPMENT

Around four-fifths of the economic impact of drought is absorbed by agriculture.[3] It is thus of particular significance in Asia and the Pacific where many people – particularly in the poorest countries – still rely heavily on agriculture for their livelihoods. In 2014, employment in agriculture as a proportion of total employment in middle- and high-income countries was 12 per cent, but in the low and middle-income countries it was 50 per cent. The pattern is similar for agriculture's contribution to the economy. In 2014, for high- and upper-middle-income countries, agriculture generated 17 per cent of the value added to GDP, while for lower-middle-income countries it generated 40 per cent.[4]

A prolonged drought will slow down income growth not just in agriculture, but also in related activities, particularly agro-processing, with knock-on effects for employment and incomes in other parts of the rural economy. The impact is greatest on poor farmers. In rural Andhra Pradesh in India, one study found that drought was the single most important factor in pushing people into poverty.[5]

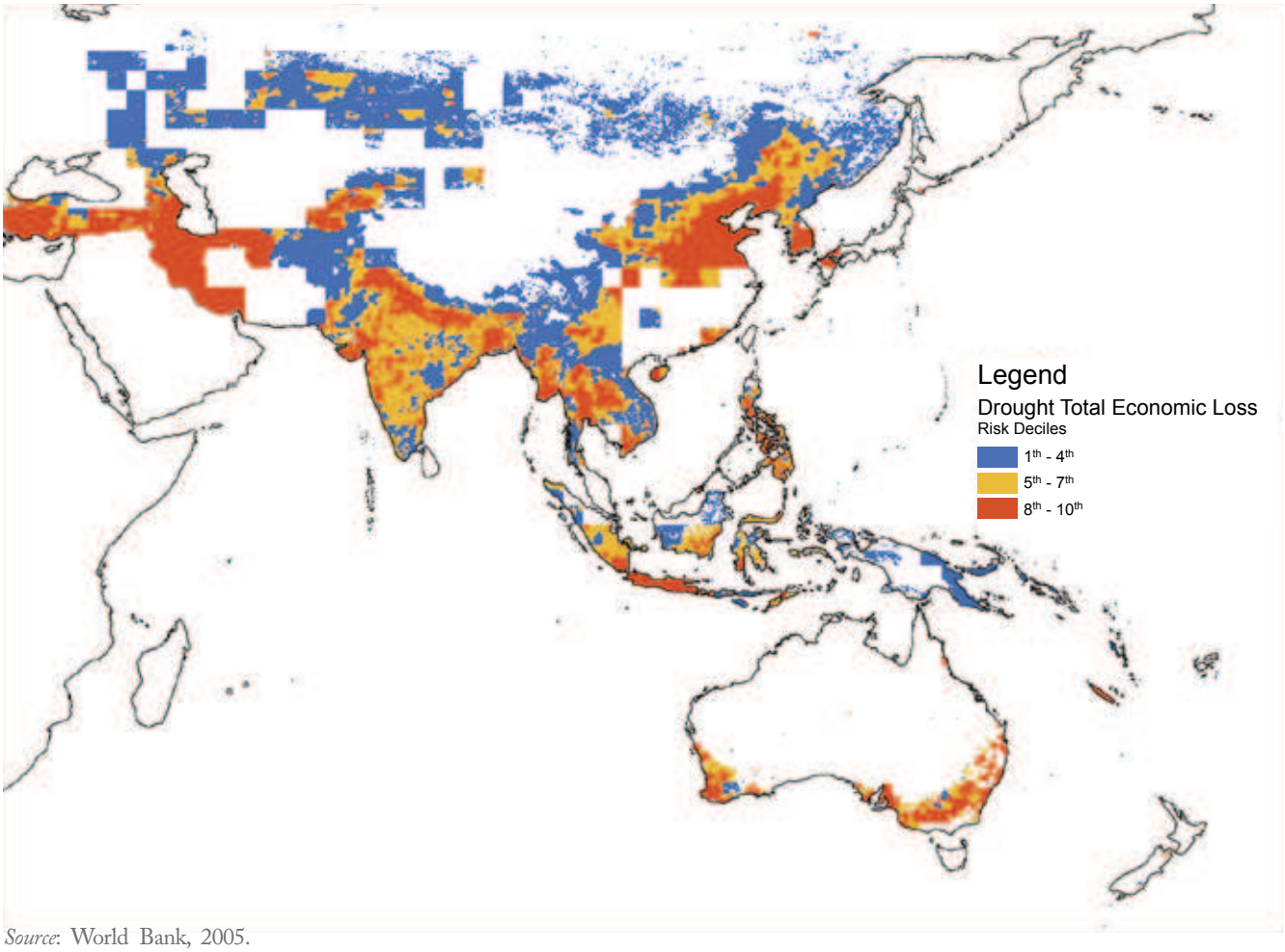
Though it is difficult to determine exact estimates of economic loss from drought, some efforts to map the risk of economic loss across the region have been made as shown in Figure II-1.

A study in three states in eastern India, for example, covering the period 1970-2002 found that in drought years farmers' incomes fell by around one-quarter (Figure II-2). In these states in a drought year almost 13 million additional people fell back into poverty which would translate at the national level to an increase in the rural poverty rate of 1.8 percentage points.[6] Part of the increase in poverty may be transitory, with some households being able to escape from poverty on their own. But other households whose incomes and assets fall below certain thresholds may end up joining the ranks of the chronically poor.[7]

The same study also considered the impact in north-eastern Thailand and southern China, though here the impact was less, because these areas have more diversified crops and livelihoods; as well as cultivating rice, farmers also grow

FIGURE II-1

Economic losses from drought



Source: World Bank, 2005.

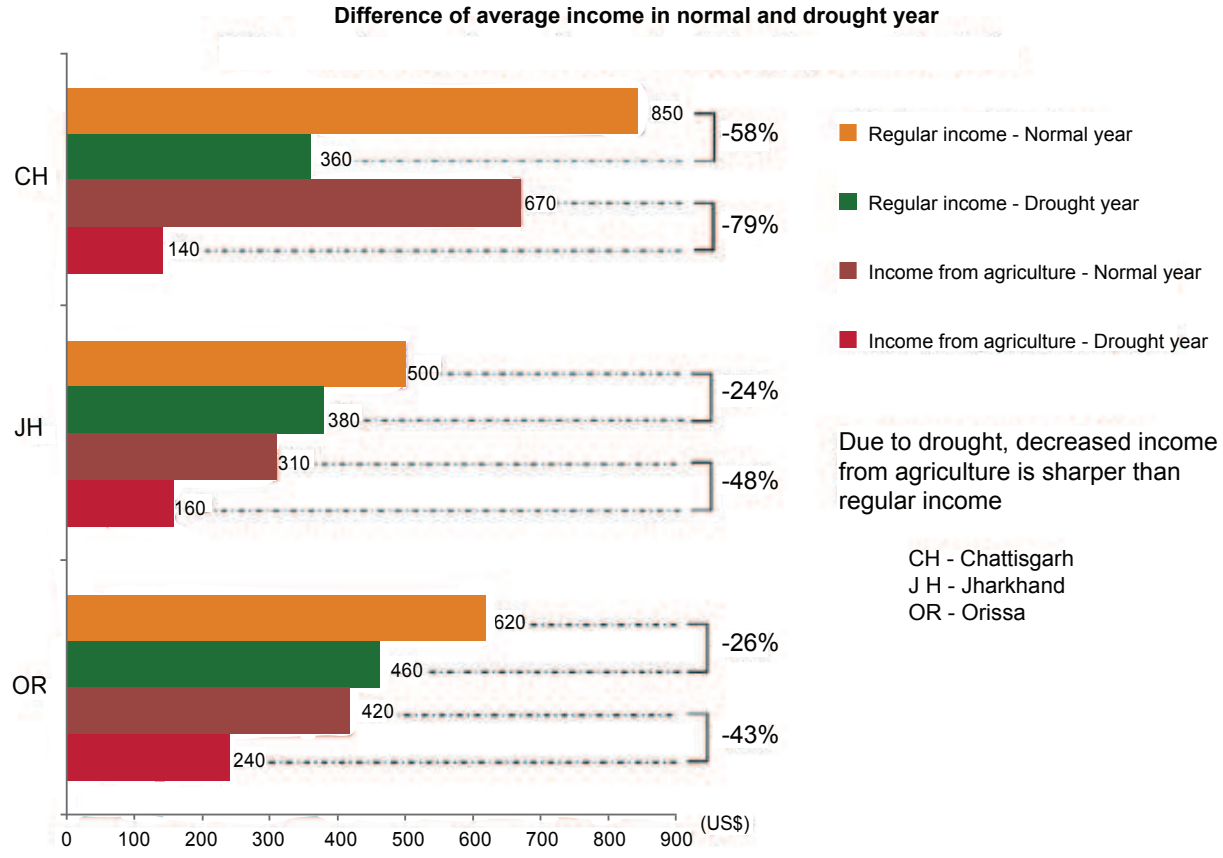
Notes: The economic risk ranges from 1-10, with 10 as the highest risk. By weighting the value of GDP exposure to drought for each grid cell by a vulnerability coefficient, it is possible to obtain an estimate of drought risk. This estimate of the drought risk can then serve as proxy for economic losses as a proportion of GDP per area. The vulnerability weights are based on historical economic losses recorded in previous disasters. The economic loss risks are then applied to GDP per unit area exposure. The weights are an aggregate index relative to losses within each region and according to the country's wealth classes over a 20-year period from 1981-2000 (classifications based on 2000 GDP).

commercial field crops that are less sensitive to drought, and in addition have more non-farm income.

Farming communities hit by drought respond in different ways. Some may be able to absorb the impact by migrating, or drawing on savings. But the poorest may resort to 'erosive' coping mechanisms, such as removing children from school, taking high-interest loans, or selling off income-generating assets (Table II-1).[8] In some cases farmers driven into debt have committed suicide.[9]

FIGURE II-2

Income loss due to a drought year in eastern India



Source: IFAD, 2009.

TABLE II-1

Major drought coping mechanisms of farm households – China, India, Thailand

Drought coping strategies	Southern China	Eastern India	North-eastern Thailand
Migration	+	++	+
Asset sale			
Livestock	0	++	+
Land	0	+	0
Borrowing	0	++	+
Consumption decline	0	+	0
Expenditure on social functions, medical treatment, and children's education	0	-	0
Use of cash and in-kind savings	+	+	+
Use of social network	+	++	+
Employment through food-for-work programme	0	+	0
Artificial rainmaking	+	n.a.	+

Source: IFAD, 2009.

Key: - Indicates a decrease, + indicates an increase, and 0 indicates no change. Double signs indicate larger change, while a single sign indicates marginal change; 'n.a.' indicates 'not applicable'.

WATER AND LAND MANAGEMENT

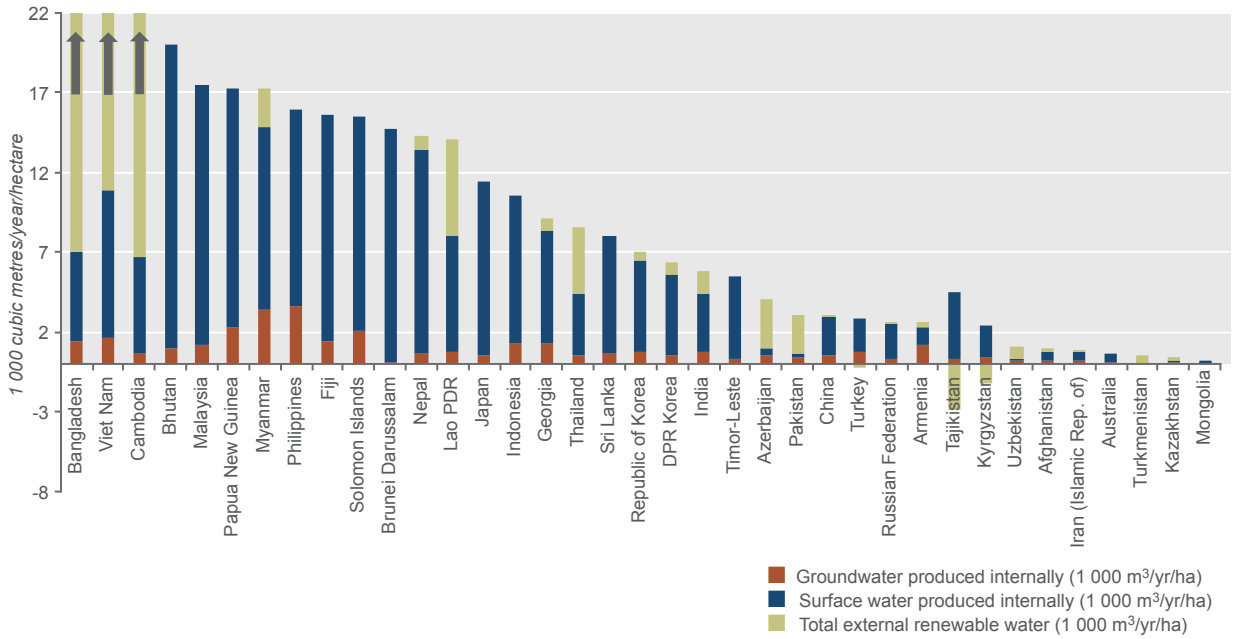
Currently around one-third of the land in Asia and the Pacific is used for agriculture – a proportion that has remained steady and is unlikely to increase since the region is already reaching its limit of available arable land.[10] Any restrictions in the available land and water have implications for food security, as it is estimated that food production will need to increase 50 per cent by 2030 and 70 per cent by 2050.[11] Drought significantly affects crop yield: estimates from India, for example, indicate that while floods reduce agricultural production on an annual average basis by 5 per cent, droughts reduce it by 12 per cent.[12]

There are three primary sources of freshwater – precipitation such as rain and snow, runoff from melting glaciers and snow, and groundwater. Figure II-3 shows the availability and source of freshwater by country as a function of the land area.[13] Consumption of freshwater for agriculture ranges from 60 per cent to more than 95 per cent in the majority of countries of Asia and the Pacific, with many countries in South, South-East and Central Asia using more than 90 per cent.[14]

Some agricultural products require more water than others, with agricultural products such as beef, rubber, cotton and biofuels using much more than other products. Livestock production in particular is very water intensive and accounts for around eight per cent of global freshwater use.[15] Several countries reliant on agriculture are relatively dry however, and therefore need strong water management strategies, particularly if water-intensive products are grown.

FIGURE II-3

Water resources by source



Source: Based on data from FAOSTAT. Available from http://faostat3.fao.org/home/E (accessed on 15 August, 2015).

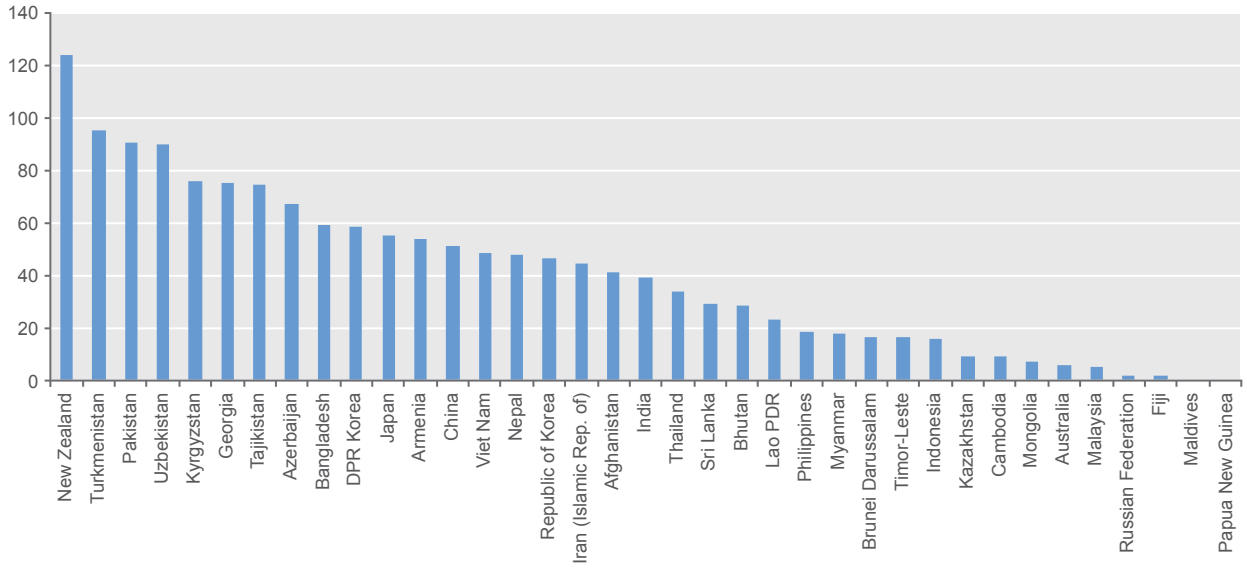
In some catchments, more water is withdrawn from sources, such as groundwater, than is replenished.[16] Water availability can also be reduced by pollution from seawater or other contaminants. This highlights the importance of water resource management which will vary from one area to another depending on how the land is managed, the type of agricultural activity, the climate and seasonal weather patterns.

Some areas can be protected from drought by irrigation, however irrigation systems in many of the region's agrarian countries are not very extensive or have fallen into disrepair. Figure II-4 shows that many countries reliant on agriculture have limited irrigation and those without generally rely on rainfall. This applies particularly to countries with regular monsoon seasons or many small island developing States, which are therefore very sensitive to irregular weather patterns.

Shortages in precipitation, combined with changes in evapotranspiration, and reduced groundwater quality and levels, can create stress and problems for crops. Drought is particularly damaging when the soil is already degraded due to the loss of soil resilience. Poor quality soils, which are less able to retain water and have less moisture available for crops, require more rainfall to produce a reasonable yield. Drought then further damages the structure, changing the composition of vegetation, or allowing noxious or poisonous species to encroach on grazing land. In the most extreme cases this leads to desertification.[17] A reduction in vegetative cover can then make the climate even drier, sustaining a downward spiral. Across Asia and the Pacific around 1,400 million hectares of land are affected by desertification – more than any other region in the world.[18]

FIGURE II-4

Percentage of cultivated area equipped for irrigation



Source: Based on data from FAOSTAT. Available from http://faostat3.fao.org/home/E (accessed on 21 August, 2015).

Since the 1970s, the land area affected by drought globally has doubled, eroding development gains and exacerbating poverty among the millions of people who depend directly on the land as a source of livelihood.[19] In South and South-East Asia, around 74 per cent of agricultural land has been severely affected by wind or water erosion, or polluted to the extent that it is no longer productive.[20] This makes it difficult to sustain development in rural areas.

El Niño

Exacerbating all of these water and land management factors is the potential impact of El Niño cycles, which in some countries increase the likelihood of drought. Scientists predicted a serious El Nino event for 2015 in Asia and the Pacific, and the tropical Pacific Ocean is already experiencing moderate El Niño levels.[21] In some parts of the region the effects can be beneficial, for example for commercial forestry, particularly in South Asia. But in many parts of Asia El Niño leads to higher temperatures and fewer rainy days which reduce the production of rice, maize and wheat.

ESCAP and the Regional Integrated Multi-hazard Early Warning System (RIMES) have assessed the likely effects in 2015 on key sectors of high-risk Pacific island countries. The strongest precipitation will be in South-East Asia and parts of the Pacific, especially in the dry season. Papua New Guinea, which is very exposed because they normally have very low dry-season rainfall, is already experiencing the impact, with more than 2.4 million people affected and dozens killed by drought.[22] In the wet season reduced rainfall could have significant impacts in the Central and Southern islands of the Pacific that depend on subsistence agriculture (Box II-1).

Climate change

It is difficult to establish a direct relationship between drought and climate change due to a lack of direct drought observations and geographical inconsistencies in monitoring drought trends. Nevertheless, climate change seems likely to increase drought risk. Compared with any preceding decade since 1850, each of the last three decades has been successively warmer at the Earth's surface. This has many implications for weather and water resources. Glaciers, for example, are an important source of water for many countries, and are already retreating at an alarming rate, and the Northern Hemisphere has seen a reduction in spring snow cover. In addition there have been changes in the patterns of extreme climate events.[23]

Increased temperatures could result in changes to precipitation patterns, earlier snowmelt, and increased evapotranspiration, which could increase the risk of hydrological and agricultural drought. There are also likely to be more frequent heat waves – which can affect agricultural production by adding stress to livestock and some crops, in turn requiring more water. A number of countries are also likely to be affected by irregular climate patterns, such as changes in the start or finish of the monsoon season.[24]

Many countries are already trying to adapt to climate change. One of the largest adaptation funds in the world is the Pilot Program for Climate Resilience. This demonstrates ways in which climate risk and resilience may be integrated into core development planning and implementation. The programme provides grants and concessional financing to a small number of countries for a wide range of activities, such as improving agricultural practices and building food security.

BOX II-1

Weather disturbances during El Niño

The Royal Meteorological Society of the Netherlands computed how El Niño perturbed the average weather over the last century.[25] This is indicated in the maps below. Blue circles indicate that during El Niño there was, on average, more rain than normal, while red circles indicate drought. From March to May the strongest effects were in the Western Pacific Ocean: along the equator rainfall increased, while at latitudes 10°-15°, North and South, rainfall decreased (Figure A). From June to August, eastern Indonesia often suffered droughts (Figure B). The rain zone moved east to the islands along the equator. The Indian monsoon was often weaker during El Niño.

Figure A: El Niño and La Niña over the last century for March-May

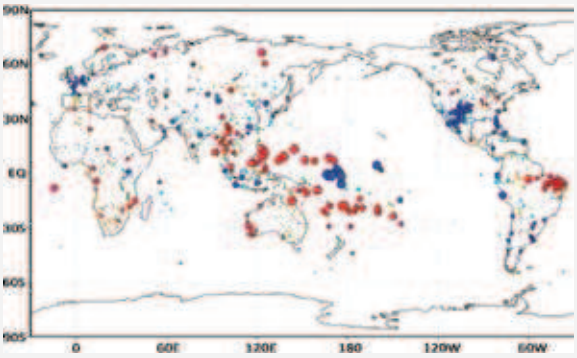
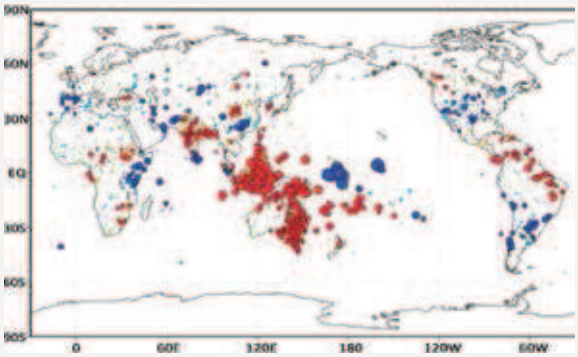
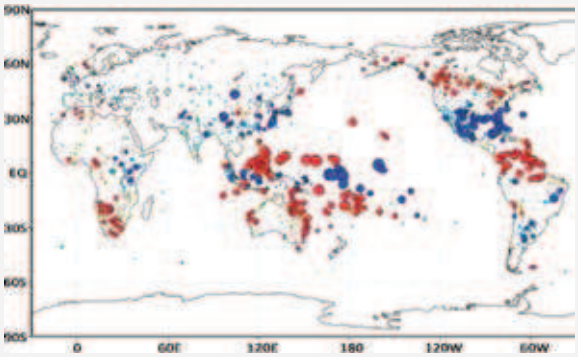


Figure B: El Niño and La Niña over the last century for June-August



From December to February, the Philippines and east Indonesia stayed drier, whereas the Pacific islands along the equator remained wetter (Figure C).

Figure C: El Niño and La Niña over the last century for December-February



Source: KNMI, 2014.

REGIONAL DROUGHT MECHANISM

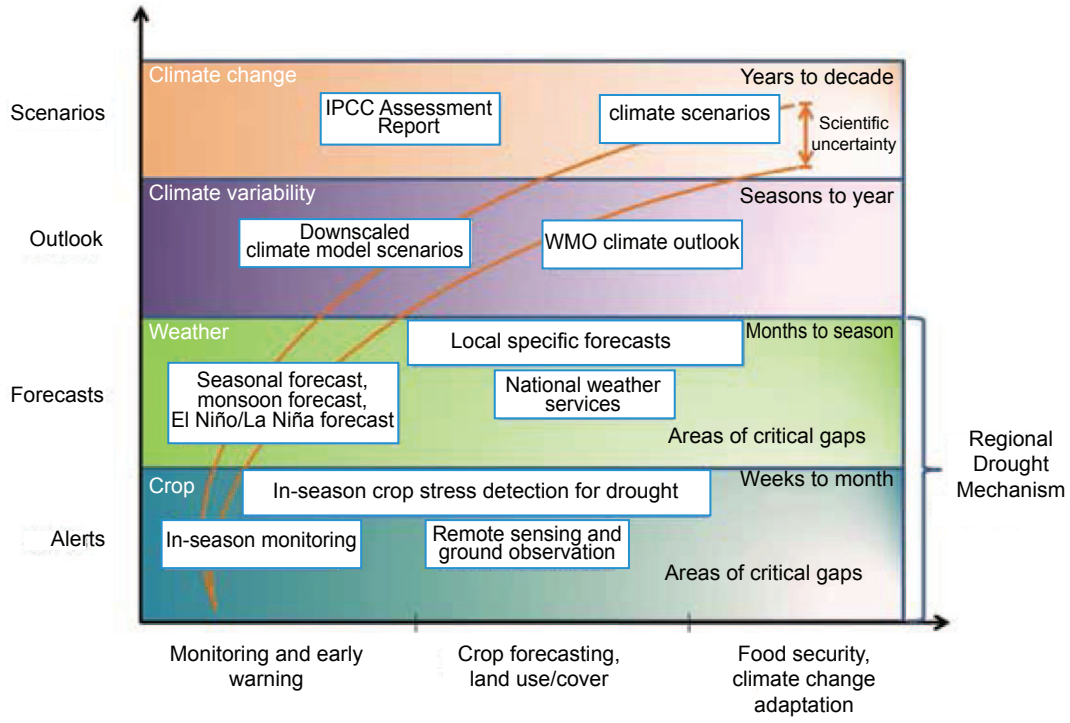
Signs of drought can be observed from space long before they are visible on the ground to the human eye. This satellite-based perspective would be useful for farmers: with suitable warnings they can take appropriate action, perhaps sourcing more water, or switching to crops that are more drought-resistant.

Some efforts have already been made to allow access to these tools and information, such as the Agriculture Stress Index System which detects agricultural areas with a high likelihood of water stress.[26] Many countries, however, do not have the institutional capacity to integrate these high-end knowledge products into their operational drought monitoring and early warning systems: they may be unable to set up the system, or to access or interpret the data. A further obstacle to effective implementation is a lack of inter-agency cooperation – for sharing the information, or presenting it in ways that can be understood and used.

For this reason, ESCAP has established the Regional Drought Mechanism. This takes advantage of data and imagery from the region's spacefaring countries – such as, China, India, Japan, Thailand and others – and shares it with other countries, especially those perennially prone to drought. This service complements WMO's Global Framework for Climate Services by providing more detailed, localized forecasts and monitoring that can be updated during the growing season. The aim is to give a comprehensive real-time drought monitoring and early warning system and to seamlessly link long-term climate scenarios with the seasonal climate outlooks (Figure II-5). Countries can

FIGURE II-5

ESCAP Regional Drought Mechanism - Global Framework for Climate Services



use this for monitoring in-season crop stress and issuing timely alerts on the onset of agricultural drought over large areas – allowing mid-course corrections and measures for drought mitigation. The mechanism also develops partnerships, and works with national governments to clarify and build the institutional network required to ensure the early warning services reach the right people.

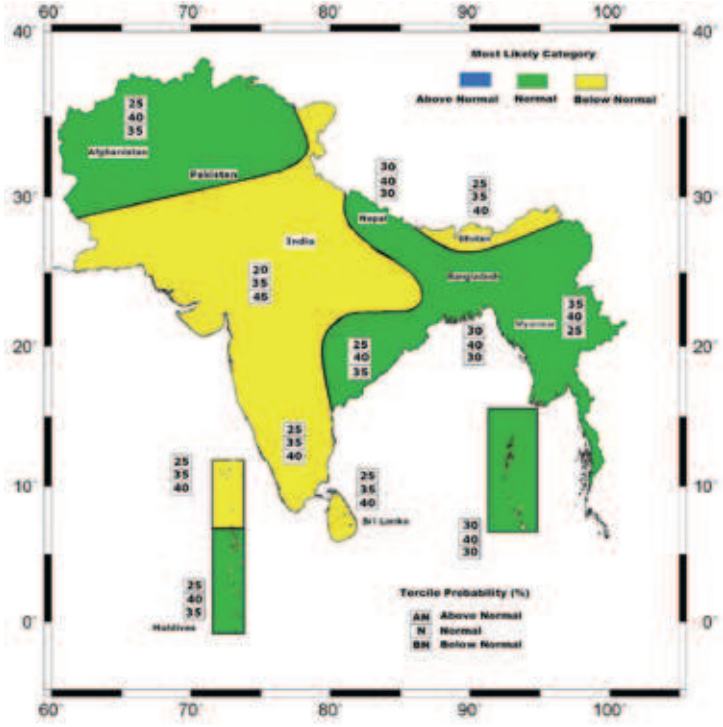
Currently, the Regional Drought Mechanism has two service nodes. Based in China and India, these provide space-based data, products, and capacity. On request, experts from these nodes and ESCAP work with member States to determine the most appropriate services, build their capacity to process and interpret the information, and disseminate the data to people that need it most.

The Regional Drought Mechanism was piloted for Sri Lanka in 2014. The pilot started with data from the WMO Regional Climate Outlook Forums and the outlook for the summer monsoon rainfall for South Asia in 2014 (Figure II-6) – which indicated an El Niño-associated drought. As a part of the drought mechanism, ESCAP and RIMES highlighted the consequent drought risk at regional, subregional and national levels, along with the potential impacts in various sectors.[27]

In addition to the seasonal outlooks, satellite data was used to determine the stress on vegetation during the growing season, indicating drought impacts. Indicators of vegetation stress (for example NDVI anomalies) were analysed for a drought year (2012) and a normal year (2005)

FIGURE II-6

Climate outlook reported for the summer monsoon in South Asia, 2014



Source: Fifth Session of South Asian Climate Outlook Forum, 2014.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

and validated through stakeholder consultations. These NDVI anomaly indicators were found to be closely linked with in-season drought conditions (Figure II-7).

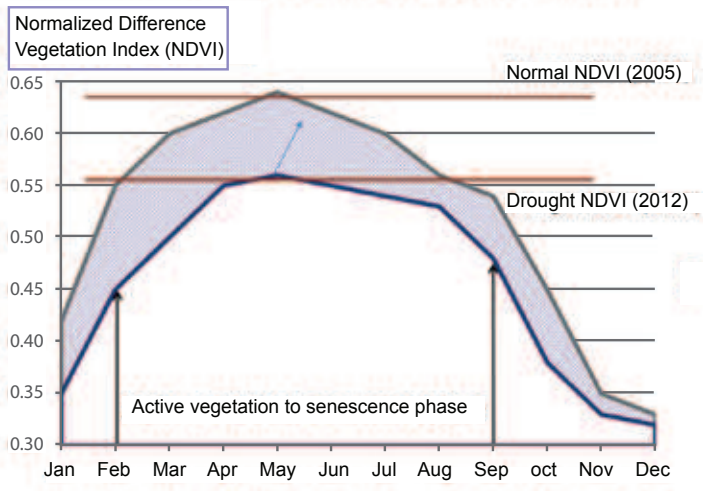
Using NDVI anomalies, Sri Lanka analysed the agricultural drought during the growing season in 2014 by comparing the degree of difference from the baseline drought year (2012) and the normal year (2005) (Figure II-8). The red areas indicate the extent to which there was less cover in 2014, and the green areas show where there was more. Analysis of this can also serve as a baseline for long-term strategies on drought mitigation, climate change adaptation and food security.

Another exercise was carried out in Mongolia. In this case the country worked with the regional service node in China. The aim was to investigate the *dzud* – drought leading to inadequate pasture or fodder, followed by a severe winter that kills much of the livestock. For this purpose, Mongolia used space and ground-based indicators such as forest cover, and the condition of the steppe and desert steppe. Figure II-9 shows a synthesis of various indices – offering an important baseline for developing a *dzud* early warning system. Other countries currently participating in the Regional Drought Mechanism include Afghanistan, Cambodia, Kyrgyzstan, Myanmar and Nepal.

The Regional Drought Mechanism is also seeking to collaborate with similar initiatives globally. These include the Group on Earth Observations for Global Agricultural Monitoring (GEOGLAM) launched in 2011 by the G20 countries. This partnership would be mutually beneficial: the mechanism would gain access to a broad range of specialized GEO data and products, while GEOGLAM would have another outlet for its forecasts. Both initiatives build on existing agricultural monitoring programmes and strengthen them through international networking, operationally focused research, and data and method sharing. Another important initiative is the Asia Rice Crop Estimation & Monitoring programme which would be strengthened by working with the Regional Drought Mechanism.

FIGURE II-7

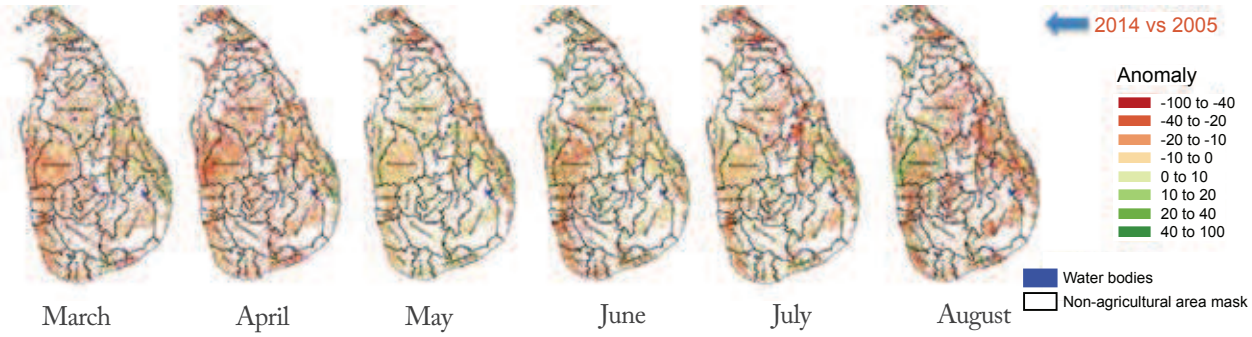
Vegetation index-based drought assessment, Sri Lanka, 2014



Notes: The normalized difference vegetation index (NVDI) is a measure of vegetation cover ('normalization' is required when combining different images to take into account differences in the sun's elevation).

FIGURE II-8

NDVI anomaly (vegetation stress) of Sri Lanka



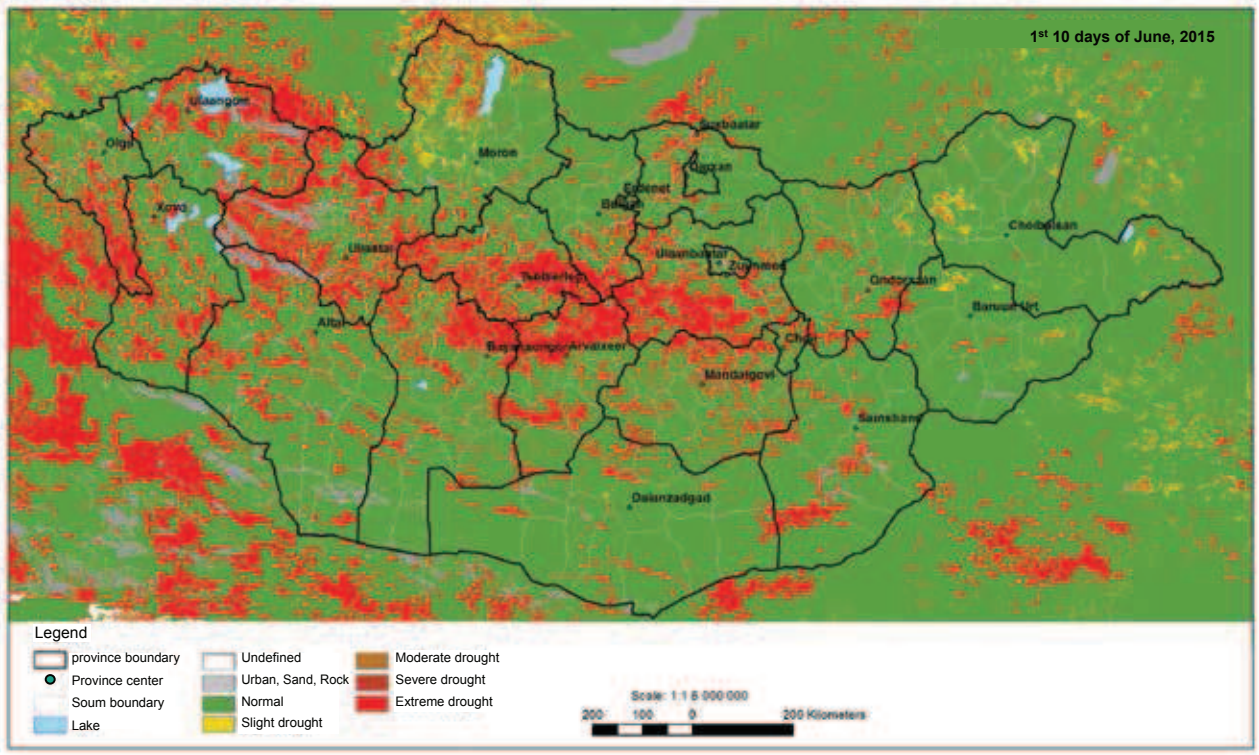
Notes: Year 2014 is compared to 2005 (normal year) and 2012 (drought year). The red areas signal high levels of vegetation stress.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Mongolia is particularly prone to *dzud* - a combination of drought and severe winter events leading to a lack of food for livestock.

FIGURE II-9

Drought in Mongolia



Source: Mongolia, 2015.

Notes: This map is based on a composite of various indices, including the normalized difference drought index, the vegetation supply water index, and the thermal condition index.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

BUILDING RESILIENCE TO DROUGHT

For drought, as for other disasters, building resilience requires a full disaster management cycle approach: mitigation and adaptation to minimize the risk; preparedness to respond as necessary; relief to assist those in need; and investment in long-term recovery. In the case of drought this is usually complicated by the multiple institutions involved – for example, ministries concerned with agriculture, water management, land management, disaster response, and planning or finance. In practice, however, most of the current activity is for response, and even that is often quite late, since droughts develop slowly and may not be noticed until they become emergencies. However, this slow onset, if recognized, also provides more time to apply additional drought management strategies compared to other rapid onset disasters.

For anticipating and mitigating the impacts of drought, there are a number of options. Governments may, for example, have a dedicated drought management policy, or they may

integrate drought management under disaster management, or they may address drought under other sectoral plans, such as those for agriculture or water. Each approach has its merits, meaning that governments will need to choose those most appropriate for their national circumstances.

- *India* – In 2005, India's Disaster Management Act established the National Disaster Management Authority chaired by the Prime Minister. In 2010 in consultation with various institutions this produced the National Disaster Management Guidelines: Management of Drought. So although drought falls under a broader disaster management strategy, it is also specifically addressed in a more comprehensive manner including mitigation, preparedness and response.
- *Australia* – In 1992, the Government developed a dedicated National Drought Policy with specific programmes and initiatives supported at the state, territory and local levels. The policy identifies the principles for addressing drought in a comprehensive manner and prioritizes it separately from other disasters.
- *Kiribati* – Kiribati has integrated various elements related to drought under its National Water Resources Policy.[28] This policy recognizes the unique circumstances of many SIDS, which rely only on freshwater available from rain, or a shallow layer, or lens, resting on seawater underground. It primarily covers issues related to sound water management and conservation.
- *Thailand* – The relevant agencies for drought are the Department of Disaster Prevention and Mitigation under the Ministry of Interior, the Ministry of Agriculture and Cooperatives, and others which operate under a single command system for prevention, preparedness, response and recovery. Depending on the severity and extent of drought, different agencies are responsible for mitigation, management and relief.[29]

In the majority of countries in the region, however, drought falls under a general disaster response policy, with the emphasis predominantly on relief.

- *Nepal* – The Natural Disaster Relief Act covers drought, yet to trigger action from the Ministry of Home Affairs there needs to be a loss of life, which may not occur until conditions are severe. Response then reverts to the Ministry of Agriculture to offer relief programmes.[30]
- *Indonesia* – The country has a National Board for Disasters Management which is also focused on emergency response.[31]
- *Republic of Korea* – Drought management falls under the Framework Act on the Management of Disasters and Safety and Countermeasures Against Natural Disasters Act. Droughts are regular but generally localized so responsibility rests with local government authorities. This has advantages though there can also be difficulties in coordination, such as accessing water resources under the responsibility of another district authority.[32]

In 2013, UN-Water, a network of international and United Nations institutions involved in water-related issues, launched an Initiative on Capacity Development to Support National Drought Management Policies. This helps drought-prone countries formulate effective risk-based national policies that assist stakeholders at all levels of government.

While the approach will differ from country to country there are often common elements, as indicated in the following sections which cover eight key issues.

- Long-term risk management
- A livelihood approach
- Management of natural resources
- Multisectoral coordination
- Using science and technology
- Regional cooperation
- Agricultural insurance
- Social safety nets

Long-term risk management

Rather than relying on short-term relief and response, countries should give a greater priority to preparedness and long-term risk management – which can mitigate the effects and allow for adaptation to changing environmental conditions. If farmers know in advance that there is a strong likelihood of drought conditions, they can plant drought-resistant crops, budget water resources more carefully, or introduce water-saving techniques (Box II-2).

Australia's most recent policy reforms, for example, recognize drought as a recurring part of the country's climate and encourage farmers to prepare for and manage this risk. In addition to offering relief in times of hardship, the Government has programmes for mitigating and adapting to the risk of drought. India uses techniques of climate variability management, which encourages farmers to build reserves during favourable seasons that they can draw on in drier seasons.[33]

Risk reduction, preparedness and mitigation can include:

- *Alternative crops* – changing to crops that demand less water or varieties that are drought-resistant;
- *Early warning and improving access to data* – for strengthening seasonal forecasts and early warning systems, along with planning and risk management;
- *Knowledge and communications networks* – for transferring information from government agencies to farmers;
- *Land management* – improving information for land management and drought planning;
- *Employment* – diversifying employment or livelihoods;

BOX II-2

Watershed management in Karnataka, India

Between 2001 and 2009 the state government of Karnataka in India partnered with several NGOs and the World Bank in seven rain-fed districts to develop a successful watershed programme called Sujala.[34] This combined cutting-edge technology with bottom-up local participation. GIS mapping was used to integrate large volumes of satellite data with non-spatial data on such issues as rainfall, literacy, and demography. This formed the basis of a comprehensive action plan for each micro-watershed that communities could use to construct a small model that enabled them to see the bigger picture and the potential risks and prioritize areas to be treated.

The Sujala project helped increase crop yields by about 25 per cent, reduce soil erosion and run-off by up to 21 cubic metres per hectare, and increase the proportion of land irrigated by between 6 and 14 per cent.[35] Farmers were able to increase their incomes and diversify to other non-farm activities, with the benefits extending to women, the land less and other vulnerable groups.[36]

- *Water conservation* – improving water retention and building storage systems;
- *Improving irrigation* – introducing high-tech irrigation systems such as drips, sprinklers or spray jets or rehabilitating irrigation and drainage systems;
- *Ecosystem management* – improving land care, water quality and environmental management;
- *Land rehabilitation* – for degraded land;
- *Education* – improved education of community and farmers for changing agricultural practices (e.g. no tillage);
- *Livestock management* – migration of stock or destocking;
- *Stockpiling* – seedbanks, feedstock and water storage at a community level;
- *Zoning* – planning and zoning to restrict agricultural practices in high-risk areas, or encourage cultivation of suitable species;
- *Improve water management* – increase water storage in watersheds, reservoirs, soil, groundwater and inland fresh water bodies;
- *Migration* – arranging temporary or permanent migration;
- *Financial risk management* – strategies during good seasons to support households during drought events.

Because most of the region's poor and vulnerable people rely on agriculture it is also important to have relief options. But these schemes should be carefully targeted because recurrent relief will drain valuable resources that could be better used for other development purposes.

A livelihood approach

Drought mitigation should support poverty eradication as part of an inclusive and sustainable development programme. This should include investment in rural infrastructure and in rural education to increase farmers' capacity to cope.[37]

- *India* – The Mahatma Gandhi National Rural Employment Guarantee Act provides employment and wages while building productive assets leading to sustainable livelihood opportunities. In addition, the National Rural Livelihoods Mission under the Ministry of Rural Development provides livelihood development opportunities to poor rural families – emphasizing capacity building of self-help groups and their federations, along with financial services and training.
- *Afghanistan* – The Government has taken steps to mitigate drought, although the policies still remain in a nascent stage. One of the best options is community-based water harvesting and sustaining micro-watersheds in drought-prone areas.[38]
- *Pakistan* – The Pakistan Poverty Alleviation Fund has made significant investments in drought mitigation and preparedness. It aims to strengthen community capacities for coping with drought. It has encouraged farmers to adjust their cultivation practices – changing crops and cropping patterns – which has led to higher yields.[39]

Maintaining ecosystems

Agriculture is part of a complex ecosystem involving interactions between living organisms and the physical environment. Agricultural systems thus need to remain within the limits of these ecosystems. This should mean, for example, maintaining healthy watersheds – allowing water to return to natural ecosystems, such as forests or groundwater aquifers, so that these resources will be available for seasons and generations to come. It is also important to maintain healthy soil systems, and limit practices that can degrade soils. This will allow water to be retained and utilized in the most efficient manner and enable the ecosystem to produce acceptable yields while

reducing the need for fertilizers. Maintaining biodiversity can reduce the impact of pests and disease that can devastate a single crop – as well as reducing the need for pesticides.

Farmers are the custodians of the land and it is in their family's best interest to maintain these resources within acceptable limits. In Asia and the Pacific, they have been tackling uncertain climate conditions and drought for centuries. One example is the *wewa* water basins of Sri Lanka, some of which are 2,000 years old and still in use. This ancient system, which covers nearly 80 per cent of the country, consists of hydrologically interconnected man-made reservoirs, one below the other. This cascade model not only reuses water but also controls both floods and droughts in the dry and intermediate zones.

Farmers who have experience in adapting to changing environmental conditions can also advise policymakers on how best to support their livelihoods. A survey of seven Asian countries – Bangladesh, China, India, Indonesia, Nepal, Pakistan and Viet Nam – found that in some countries, almost a half of the respondents were concerned about changes to the environment. Many farmers were already rotating crops or planting different ones but only a few felt informed about what they could do to cope with these changes.[40]

A number of countries emphasize the importance of involving farmers in ecosystem management.

- *Australia* – The 1992 National Drought Policy recognizes the role of farmers in national resource management, the importance

UN PHOTO/MARTINE PERRET

of maintaining and supporting the natural resource base during drought and climate change, and the need to enhance long-term sustainability and resilience.

- *India* – India has taken a watershed development approach to agricultural production and has been improving and reforesting ten million hectares of degraded land in an effort to restore important watersheds and their ecosystem services.[41] These programmes were established under India's National Disaster Management Guidelines: Management of Drought, and include a participatory approach, including ecosystem-based and technical interventions as well as economic and social support – for example, women's self-help development and capacity building. A number of market and non-market benefits have been identified (Box II-3).
- *Turkey* – The agricultural policy includes a basin-based support programme that provides incentives for growing crops in areas that have the most suitable ecological conditions.[42]
- *Viet Nam* – Considerable work has been undertaken to reforest around five million hectares of land to protect and regulate water resources and watersheds.
- *Russian Federation* – Conservation-based practices have been helping mitigate the impacts of drought. These include the use of new drought-resistant crops zoned for particular areas, protective afforestation, planting to help maintain soil moisture, and the use of agricultural methods that are less likely to damage the soil.[43]
- *Kiribati* – Goal one of the water management policy recognizes the importance of sustainable water resource management. Goal two emphasizes community involvement and responsibility.[44]

A number of the SDGs highlight the importance of sustainable agriculture. To achieve this, goal 2.4 states '(b)y 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality'.

Multisectoral drought management

An effective end-to-end drought management programme is multisectoral. It requires extensive coordination and planning, along within formation sharing arrangements across all the key stakeholders – involving many government ministries as well as subnational and local authorities and other non-government stakeholders as appropriate. This is a complex process and may take years of refinement and revision.

- *Thailand* – Drought management falls under comprehensive disaster management legislation coupled with a master plan on drought, primarily administered by the Disaster Prevention and Mitigation Policy Bureau. Requirements under the plan vary depending on the level of government and the severity of drought and involve a large number of institutions in various aspects of drought mitigation, early warning, response and management (Table II-2).
- *India* – Guidelines adopted in 2010 under the Disaster Management Act 2005 identify the roles and responsibilities of various sectoral departments from national to local levels. The National Disaster Management Authority, headed by the Prime Minister, has the primary responsibility for developing and implementing policies, plans and guidelines; though a number of other institutions are

BOX II-3

Watershed development for drought mitigation

Watershed development provides many valuable market and non-market benefits – though these are often neglected or undervalued in decision-making. Assigning an economic value to these benefits can assist policymakers in making funding decisions and also increase public awareness of the value of an ecosystem-based approach. Economists have developed methods for quantifying non-market benefits, such as stated preference, revealed preference, and benefits transfer approaches. The tables below summarize the benefits from a watershed development programme in Kumbharwadi, India.

Market and non-market benefits of watershed development in Kumbharwadi, India

Market benefits	Non-market benefits
Improved crop sales	Carbon sequestration
Improved livestock sales	Habitat improvement/biodiversity
Avoided travel cost for migratory work	Improved nutrition and health
Avoided travel cost for drinking water	Improved diversity in diet
Avoided cost of government supplied water tankers	Increased enrolment in education
Improved fuel wood and fodder supplies	Female empowerment
	Community development
	Improved resilience to drought
	Pollination
	Water filtration

Indicators of watershed improvement

Indicator	Unit	Reporting year		
		1998	2002	2010-2011
Government-supplied water tankers	Number/year	25-30	0	0
Average depth of water table below ground level	Metres	6.5	3.5	3
Land under irrigation (perennial)	Hectares	0	9.72	50
Total crop area	Hectares	457	510	566
Value of cropland	Rupees/hectare	15,000	65,000	65,000
Wells	Numbers	63	85	91
Agricultural employment	Months per year	3-4	8-9	12
Agricultural wage rate	Rupees	25	65	225

Source: WRI, 2013.

TABLE II-2

Multisectoral drought management in Thailand

Institution	Drought risk assessment	Drought database and GIS system	Drought monitoring and forecasting system	Drought database and hazard map update	Mobilizing human resources and equipment during drought	Post-drought
Department of Disaster Prevention and Mitigation	x	x	x	x	x	
Department of Royal Irrigation	x	x	x	x	x	
Department of Land Development	x	x	x	x	x	
Department of Agricultural Extension	x	x	x	x	x	
Department of Groundwater Resources	x	x		x	x	
Thai Meteorological Department	x	x		x	x	
Geo-Informatics and Space Technology Development Agency (Public Organization - GISTDA)		x	x	x	x	
Department of Water Resources	x			x		
Department of Forest				x		
Department of Natural Parks, Wildlife and Plant Conservation				x		
Permanent Secretary Office of ICT			x			
Department of Public Relations			x			
Provincial and District Offices of these Departments	x	x	x	x	x	x
Local Administration Authority	x	x	x	x	x	x
Bangkok Metropolitan Authority	x	x	x	x	x	x
Ministry of Finance					x	x
Ministry of Labour						x
Ministry of Public Health						x
Ministry of Agriculture and Cooperatives						x
Ministry of Human Development and Social Security						x

responsible for administering various programmes, in particular the Ministry of Agriculture.[45]

- *Australia* – In 2013, an Intergovernmental Agreement on the National Drought Program Reform was reached between the commonwealth, state and territory governments and identified the roles and responsibilities of each. The National Drought Policy 1992, which still underlies drought legislation and programmes, identifies the Department of Agriculture as having the primary responsibility for the National Drought Policy development. Prior to this,

drought was treated as a natural disaster under the Natural Disaster Relief and Recovery Arrangements administered by the Australian Government Attorney-General's Department.[46]

- *Sri Lanka* – The Government is establishing a drought monitoring and response programme which involves several sectoral agencies including agriculture, water management, irrigation, meteorology, natural resource management, disaster management, statistics, and science and technology. With the support of ESCAP's Regional Drought Mechanism, the Government established a network of relevant institutions through memorandums of agreement identifying their roles and responsibilities.[47]

One forum which could serve countries well in bringing together various government agencies and other institutions is the Monsoon Forum which has been established in a number of Asia-Pacific countries.

Using science and technology

Science and technology play an important role in planning, mitigation, adaptation, forecasting and early warning of drought. Malaysia, the Philippines and Thailand, for example, have been seeding clouds as a method of mitigating drought. In addition, a number of countries have research programmes for adapting plant species to be more drought tolerant.

Over the past decade, the opportunities for using advanced technology have expanded dramatically, particularly in the area of space applications, hydrology and meteorology. Global satellite systems can identify and monitor areas affected by, or prone to, drought. This data, with other information, can be fed into geographic information systems to build an extensive drought monitoring model to aid the accurate estimation of soil moisture and indicate how it will affect crop production (Box II-4).

BOX II-4

Land cover mapping

Measures for drought mitigation and adaptation benefit from close monitoring of land cover. This is because different land uses retain water better than others. Geospatial science can monitor changes in land cover and allow farmers to act accordingly before dryness or drought sets in. Currently, there are several sets of global land cover maps at different levels of resolution. Until 2014, the highest resolution product (300 metres to one pixel) was GlobCover produced by the European Space Agency (ESA). The resolution of other datasets such as IGBP-DIS Cover from USGS, UMD GeoCover from the University of Maryland, and BU_MODIS from Boston University, all have resolutions of 1,000 metres. In 2010, China launched Remote Sensing Mapping and Research on Key Technologies of Global Land Cover (GlobeLand30 or GLC30), which provides a 30-metre spatial resolution.

In terms of total land use, this type of mapping indicates, for example, how more land is now being swallowed up by urban areas. In Asia and the Pacific over the period 2000-2010 around 25,000 square kilometres were lost – 72 per cent came from cultivated land, followed by grassland (15 per cent), forest land (7 per cent), bare land (5 per cent) and shrub land, wetland and water bodies (all less than 1 per cent).

Combining these data with ground-based information, such as hydrological, meteorological and soil quality data, can produce a variety of ecological, climatic and hazard maps. The Russian Federation has had 20 years of experience in utilizing satellite data for detecting drought losses. China and India have also been developing drought monitoring and hazard maps (Figure II-10).

Mapping based on microwave remote sensing technology can be particularly valuable for monitoring snow and ice cover, since countries reliant on snowmelt and glacial runoff for water resources may have more time for adaptation if they get the information several months in advance – planting drought-resistant crops, perhaps, or importing additional food supplies. The mountains of Kyrgyzstan and Tajikistan, for example, are an important source of water for the Amu Darya watershed. Mapping demonstrated that the water available from snow and ice fell between 2010 and 2011 (Figure II-11).

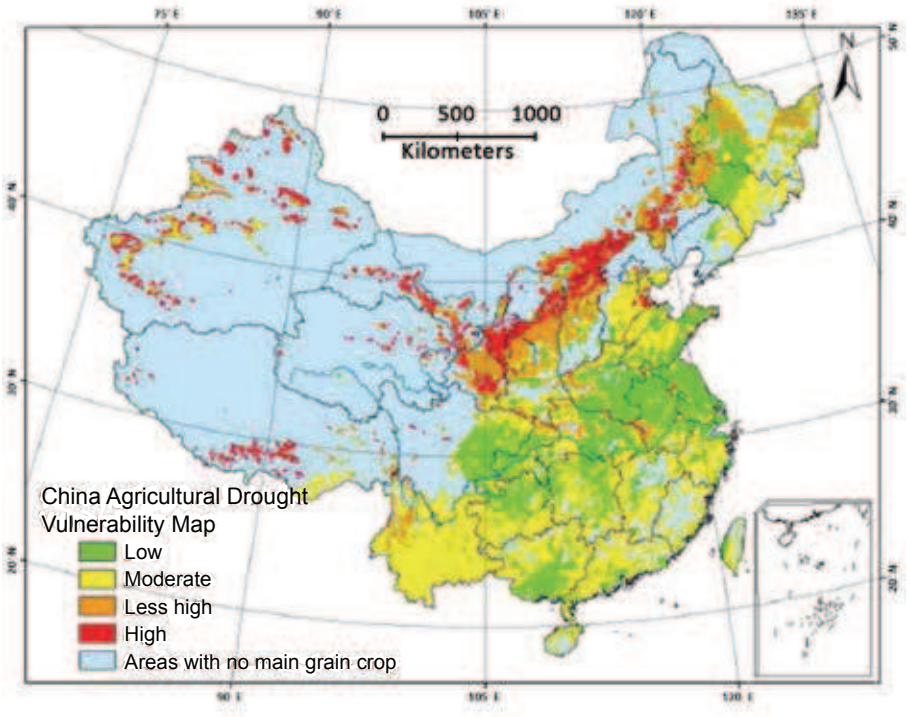
A number of other innovative technologies are discussed in greater detail in Chapter 4.

Regional cooperation

Watershed catchments and drought do not recognize national boundaries and water problems and solutions are often transboundary. This provides a good opportunity for subregional and regional cooperation. The Regional Space Applications Programme for Sustainable Development, for example, helps countries

FIGURE II-10

Satellite-based drought vulnerability map for China

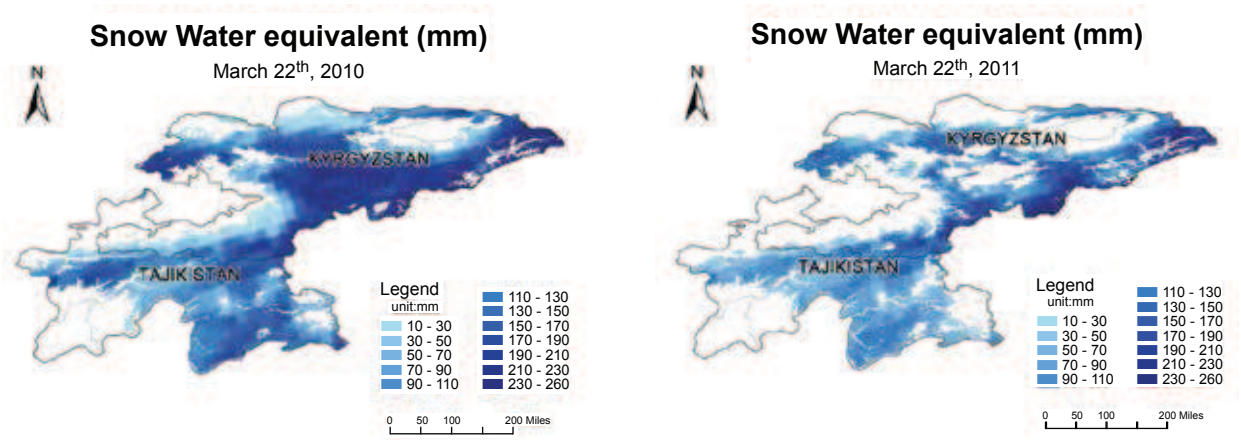


Source: Beijing Normal University, 2015.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

FIGURE II-11

Snow water equivalent monitoring in Kyrgyzstan and Tajikistan, 2010 and 2011



Source: Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, 2015.

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

collaborate on space-derived information. The Regional Drought Mechanism now offers an opportunity for using this data to monitor drought. In Central Asia, Kyrgyzstan has expressed an interest in becoming a focal point for the Regional Drought Mechanism, while Kazakhstan and Kyrgyzstan have established a joint emergency and disaster risk reduction centre. Pacific island States in particular have great potential for establishing a subregional institution with the necessary technical capacity to serve the needs of member States.

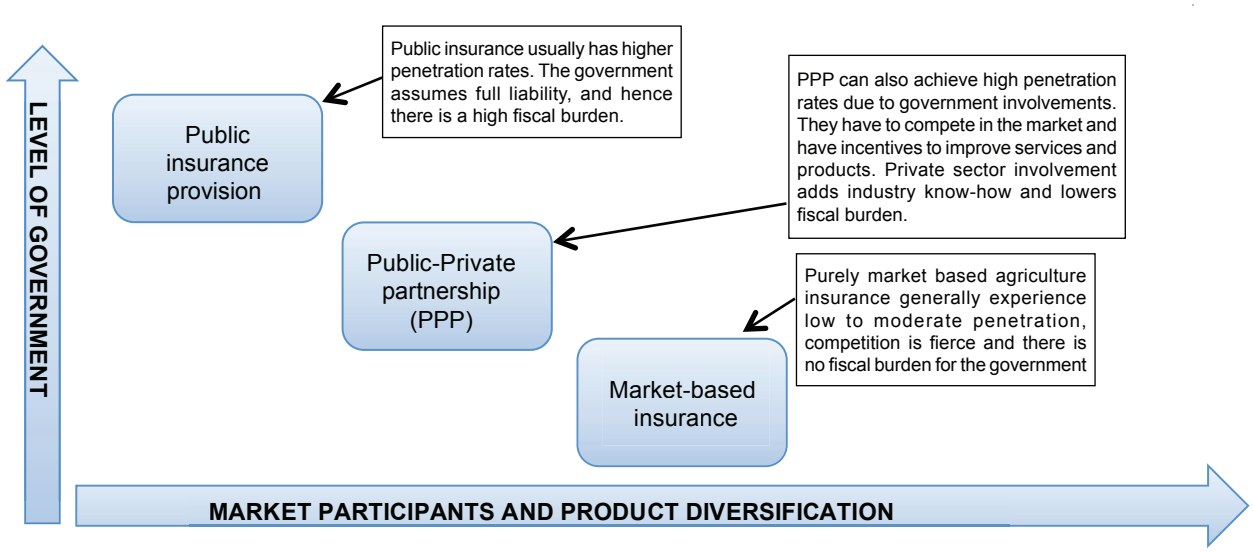
Considerable opportunities also exist for other forms of regional cooperation for drought. Food banking initiatives are already taking place in some subregions, and great potential exists for sharing food production or drought mitigation technologies and knowledge, including genetic materials and seeds for drought resistant crops. Seed banking and emergency food aid from neighbouring countries can help during times of crisis. An ecosystem based approach would also require subregional cooperation where watersheds cross national boundaries. Efforts in sharing policy information and experience, including financial strategies, institutional arrangements and social protection policies, would greatly help the many countries of the region which are only at the preliminary stage of addressing drought in a holistic manner.

Agricultural insurance

To some extent households should be able to build up their own resources to act as a buffer should they be hit by drought. But they could also have access to agricultural insurance products. These have long been available in the region's developed countries, but since the late 1970s, a number of developing countries have had programmes for multiple-peril crop insurance– as in Bangladesh, China, India, the Philippines and Thailand. These can be provided by the public or private sectors, or by public-private partnerships (Figure II-12).

FIGURE II-12

Agricultural insurance models



Source: Iturrioz, R., 2009.

In general, agriculture insurance schemes have not been very effective for drought protection. Commercial insurers are often unwilling to cover natural disasters and there are problems of adverse selection if the insurance is taken out primarily by those most at risk. Moreover, insurers often struggle to quantify drought risk, especially when the onset and end times are uncertain. On the demand side, farmers might regard insurance as an expensive luxury especially if they expect post-disaster compensation and tax breaks. They may also worry that they will have to wait for on-site inspections before they get compensation.

In many countries, agricultural insurance is provided by the government. But for drought this can be difficult to manage. In the Russian Federation, for example, there is no standardized definition of drought; agro-meteorologists use one definition while the Ministry of Agriculture uses another.

In these circumstances, a useful alternative is parametric or weather index insurance. In these schemes, payouts are based on defined parameters such as rainfall or temperature data issued by public institutions. Insured farmers receive the same payout if predetermined thresholds are reached. Such schemes do not require on-site assessment and can payout quickly. And generally they are more transparent which is especially useful in countries where the trust in the insurance industry is low.

Nevertheless parametric insurance is still in its early stages and needs further development to become a sustainable drought risk financing product. There are a number of issues. One is that in the absence of accurate crop growth modelling, the payouts may not correspond well with the actual damage – leading to under- or over-compensation. Parametric insurance also requires a higher technical capacity than traditional insurance along with accurate and frequently updated data. Fortunately, computing

technology should help improve the actuarial calculations.[48] This should be an opportunity for public-private partnerships. An example of a parametric insurance scheme for India is outlined in Box II-5.

Social safety nets

When farmers lose their crops or livestock as a result of drought they should be able to rely on public social safety nets. If these measures need to be employed regularly, however, they can become a serious burden on the government – underlining the importance of comprehensive disaster management to minimize the risk and impact. Many Asia-Pacific countries already have significant experience in administering relief packages:

- *China* – A variety of agencies are involved during a drought event. Storehouses around the country contain daily necessities, equipment and material that can be accessed rapidly. The system guarantees that people affected by a hazard can receive aid such as food, clothing, and clean water within 24 hours. The hazard relief emergency fund provides financial assistance for daily needs and for water pumps, though insurance is also increasingly important for compensating losses.[49]
- *Malaysia* – The Government has offered a number of forms of aid to relieve the impacts of drought. During 2014, for example, it provided RM1,400 ($400) per hectare of damaged crop to paddy farmers and set up a fund of initially RM10 million, later

BOX II-5

Weather-based parametric crop insurance

Parametric insurance was introduced as early as 2003 in India – the Weather Based Crop Insurance Scheme. This has been heavily subsidized, with an average subsidy of 63 per cent of the premium which has made it difficult for private sector companies to compete.[51] The Government has however recently agreed to issue the same subsidies to private sector parametric insurance companies.[52]

Subsequently parametric insurance has been provided in Asia and the Pacific by a number of private companies. The major players include ICICI Lombard and IFFCO Tokio General Insurance Company. But there are also some micro-insurance providers such as BASIX, which specializes in products for smallholder farmers with limited access to formal credit and risk transfer channels.

One problem in India is that many drought-prone regions do not have daily weather data. It is estimated that an additional 10,000 weather stations would be needed to improve weather data quality, which could cost $6 million to set up, and an additional $1.5 million annually for maintenance. Moreover, there are significant time lags in getting the information from weather stations which hinders the timely provision of compensation.

In 2008 China has initiated a pilot with the World Food Programme and the International Fund for Agricultural Development. While the pilot did raise awareness of the value of agricultural insurance it too suffered from a lack of weather data infrastructure.

increased to RM50 million, for assistance to the agriculture sector.[50]

- *India* – The main relief option during a drought is the provision of employment. Each state government provides work programmes within a five-kilometre radius. However, funding for these activities is generally inadequate, and there are restrictions on the number of family members who can be employed. The state governments also try to combine these employment schemes with water conservation programmes.[53]
- *Thailand* – During a drought event, a number of actions are triggered at the provincial level. Emergency response teams mobilize equipment such as water pumps and provide food for cattle. The Department of Royal Rainmaking and Agricultural Aviation will often try to trigger rainfall events. Several agencies are involved in surveying and preparing a list of victims, loss and damage, and issuing loss certificates for compensation. If necessary, further financial support is allocated from the Ministry of Finance.

A COMPREHENSIVE ECOSYSTEM-BASED APPROACH

The most effective way to address drought is through comprehensive risk management focusing on long-term mitigation and adaptation rather than just short-term relief. This begins by recognizing that agriculture is part of an ecosystem that needs to be maintained to ensure productivity. Drought risk mitigation also needs to address livelihoods, helping people where appropriate to diversify from agriculture to sustainable non-farm incomes. At the same time the risk of drought should encourage constant vigilance, combining high-tech monitoring with local information and knowledge, along with regional cooperation, such as through the Regional Drought Mechanism. But countries also need ways of mitigating risk, through insurance, for example, and governments should help people in need when drought becomes a crisis. This can be a long and complex process but is essential for poverty eradication, long-term food security and sustainable development.

UN PHOTO/MD. AKHLAS UDDIN

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