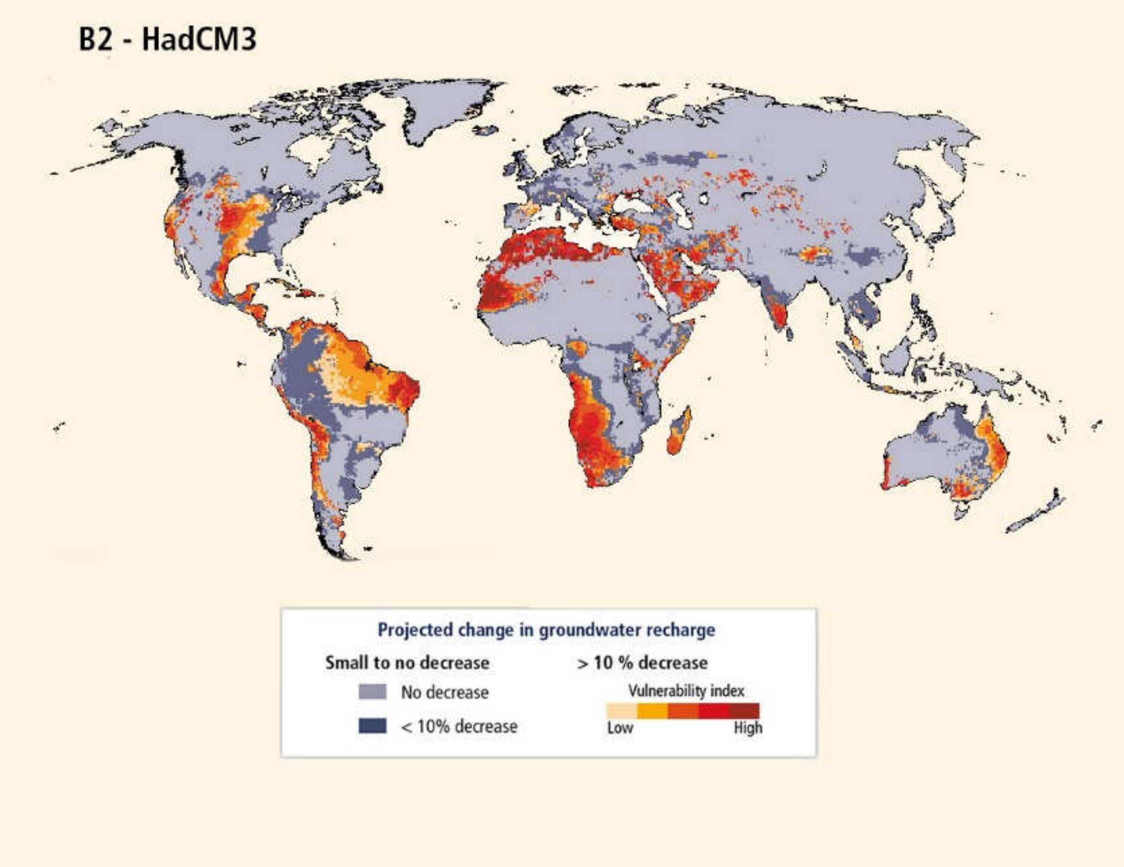
6) Impact of Climate Change on Water Supply



WG2 Chapter 3, Figure 7. The impact of climate change on renewable groundwater resources by the 2050s, for a low emissions scenario. The map also shows the human vulnerability index, which is only defined for areas where the groundwater recharge is projected to decrease by at least 10% relative to 1961-1990.

Summary:

- About 80% of the world's population already suffers serious threats to its water security, as measured by indicators including water availability, demand and pollution.
- Climate change is predicted to lead to increased precipitation variability and decreased water storage in snow and ice. In turn, this will lead to increased variability of river flow (including both flooding and drought) which will in turn lead to a less reliable surface water supply.
- Each degree of warming is projected to expose an additional 7% of the world population to a 20% or more reduction in their renewable water resources.
- By 2050, up to 1 billion people could live in cities with perennial water shortages (less than 100 litres of sustainable surface and groundwater flow per person per day).

Case Study: Water saving Irrigation in China

Water-saving irrigation (low pressure pipes, spray irrigation and micro or drip irrigation) has enhanced climate change adaptation capacity, improved ecosystem services, and promoted regional sustainable development in China.

Per capita, freshwater availability in China is among the lowest in the world and increasingly in short supply. China's agriculture currently accounts for 65% of total annual water consumption. With climate change, population growth and a growth in non-agricultural water consumption, China's agriculture could be faced with a severe shortage of water resources.

Water-saving irrigation, in particular micro-irrigation which drips water directly onto the roots of plants, is one effective measure to deal with water scarcity and food security issues. Through water-saving irrigation practices, the water saved from 2007-2009 was equivalent to 5.6%-11.8% of the national total water consumption.

In addition, about 21.83-47.48 Mt CO_2 emissions were saved (compared to an annual total emission of 6786 Mt CO_2in 2007). Therefore, the positive benefits of water saving irrigation have included mitigating climate change and promoting sustainable development.

	2007	2008	2009
Water saved (Btu^2)	19.37-40.86	19.86-41.55	22.58-57.25
Energy saved (Mt)	2.92-6.39	3.08-6.72	3.57-7.73
CO_2 emission reduction (Mt)	6.66-14.58	7.02-15.31	8.15-17.59

In recent years, a rise in precipitation and temperature has led to the melting of glaciers and expansion of inland high mountain lakes, contributing to alpine grassland degradation in Northern Tibet. Among many grassland protection measures, alpine grassland water saving irrigation measures could be effective in redistributing and making full use of increased precipitation and lake water in the dry period. A three-year demonstration of alpine grassland water saving irrigation measures showed that alpine grassland primary productivity nearly doubled while the number of plant species increased from 91 to 129, helping to protect and restore the alpine grassland ecosystem and ecosystem services and to promote regional, socioeconomically sustainable development.

Additional Source: Cost-effectiveness analysis of water-saving irrigation technologies based on climate change response: A case study of China, X. Zou, Y. Li, R Cremades, Q. Gao, Y. Wan and X. Qin, 2013, Agricultural Water Management, 129, 9-20.

Case Study: Upper East Region, Northern Ghana

Image credit https://de.wikipedia.org/wiki/Upper_East_Region#/media/File:Ghana-karte-politisch-upper-east.png .

The Upper East Region of northern Ghana has, since colonial times (1904-1957), been the poorest part of the country. The area suffers from difficult semi-arid climatic conditions, relatively high population density and patterns of underdevelopment, which are the result of discriminatory colonial and post-colonial policies. Climate change (a decrease in precipitation, increase in temperature and evapotranspiration and a shift in the rainy season) and land degradation have considerably altered the conditions for rain-fed agriculture in Northern Ghana. Furthermore, population pressure has led to continuous farming of the available agricultural lands causing land degradation. Crop failure and decreasing yields that result from these environmental changes have caused further impoverishment. In the past, youth often opted for migration to Ghana's wealthier south, in order to supplement meagre agricultural livelihoods.

Since the mid-1990s there has been a farmer led initiative to develop shallow groundwater irrigation (SGI) for vegetable gardening of tomatoes, onions and peppers. This development has helped to ameliorate poverty and to reverse rural-urban migration.

However, while the irrigators were initially able to profit from the development of good road access to northern Ghana and an increasing demand for vegetables in Ghana's south, many now frequently meet with market failure. The sale of fresh tomatoes is met with stiff competition from small-scale farmers from neighbouring Burkina Faso and Ghana's market is flooded with cheap tomato paste from countries where the production of tomatoes is highly subsidised. Global and regional competition has started to render SGI, developed as a means to locally adapt to environmental change, increasingly risky. As markets become as unreliable as the rains, Ghanaian farmers now face the uphill task of dealing simultaneously with global climate change and globalisation.

Additional Source: Laube, Wolfram; Awo, Martha; Schraven, Benjamin (2008) : Erratic rains and erratic markets: Environmental change, economic globalisation and the expansion of shallow groundwater irrigation in West Africa, ZEF Working Paper Series, No. 30, http://nbnresolving.de/urn:nbn:de:0202-20080911309
There is a video about managing water resources at
https://www.youtube.com/watch?v=R9BB0XdRxEA

Further Information:

Freshwater-related risks of climate change increase significantly with increasing greenhouse gas emissions. Renewable surface water and groundwater resources will be reduced significantly in most dry subtropical regions. Surface and ground water availability has an impact on agriculture (for food and livestock food production), energy production (with a direct impact on hydro-electric power production and crop growth for bioenergy crops as well as on the water cooling for most power plants), domestic water supply and sanitation and freshwater ecosystems.

WG2 FAQ3.2 How will the availability of water resources be affected by climate change?

Climate models project decreases of renewable water resources in some regions and increases in others, albeit with large uncertainty in many places. Broadly, water resources are projected to decrease in many mid-latitude and dry subtropical regions, and to increase at high latitudes and in many humid mid-latitude regions. Even where increases are projected, there can be short-term shortages due to more variable streamflow (because of greater variability of precipitation), and seasonal reductions of water supply due to reduced snow and ice storage. Availability of clean water can also be reduced by negative impacts of climate change on water quality; for instance the quality of lakes used for water supply could be impaired by the presence of algae producing toxins.
In the future, groundwater may be a more reliable water supply than the surface water supply. However, this is only sustainable where, over the long term, withdrawals remain well below recharge, while care must also be taken to avoid excessive reduction of groundwater outflow to rivers. The percentage of the projected global population that will suffer from a decrease of renewable groundwater resources of more than 10% between 1980 and 2080 is projected to be between 24-38%. For each degree of global mean temperature rise, an additional 4% of the global land area is projected to suffer a groundwater resources decrease of more than 30% and an additional 1% to suffer a decrease of more than 70%.

WG2 FAQ 3.3: How should water management be modified in the face of climate change?
Managers of water utilities and water resources have considerable experience in adapting their policies and practices to the weather. But in the face of climate change, long-term planning (over

several decades) is needed for a future that is highly uncertain. A flexible portfolio of solutions that produces benefits regardless of the impacts of climate change (“low-regret” solutions) and that can be implemented adaptively, step by step, is valuable because it allows policies to evolve progressively, thus building on – rather than losing the value of – previous investments. Adaptive measures that may prove particularly effective include rainwater harvesting, conservation tillage, maintaining vegetation cover, planting trees in steeply-sloping fields, mini-terracing for soil and moisture conservation, improved pasture management, water re-use, desalination, and more efficient soil and irrigation-water management. Restoring and protecting freshwater habitats, and managing natural floodplains, are additional adaptive measures that are not usually part of conventional management practice.

The full booklet, together with a significant amount of further information, a glossary and explanation of units can be downloaded from www.metlink.org

Further information about the carbon and water cycles, and wider support for GCSE and A level geography can be downloaded from www.rgs.org/schools

Unless otherwise stated, all the figures, tables and Frequently Asked Questions referenced in this booklet may be downloaded from the IPCC website or www.metlink.org

IPCC, 2013*: Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2014*: Climate Change 2014: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2014*: Climate Change 2014: Mitigation of Climate Change. Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change.

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