WANA Institute

FRIEDRICH EBERT STIFTUNG

CLIMATE CHANGE ADAPTATION IN JORDANIAN COMMUNITIES:
Limitations, Opportunities and Incentivisation

West Asia-North Africa Institute, October 2016

All content of this publication was produced by senior researcher Lara Nassar with assistance of researcher Kamal Kakish.

Published by the WANA Institute, Royal Scientific Society in Amman, Jordan.

Design: Lena Kassicieh, Head of Communications
Cover image: Taken by photographer Ken Kistler
Editing: Dr Erica Harper, Dr Gilbert Ramsay and Adel ElSayed Sparr

Printed in Amman, Jordan

Table of Contents

Executive Summary

Jordan's climate is changing. Average temperatures are increasing, while rainfall is declining. These trends are projected to worsen, and will not be limited to progressive changes such as heat and drought. Destabilisation of climate systems is expected to make sudden and extreme weather events more common. In Jordan's case, this likely means an increase in flash flooding and unexpected frosts.[1]

The implications scarcely need spelling out. According to United Nation Development Programme (UNDP) figures,[2] Jordan is already one of the world's 10 water poorest countries. It may even be the second poorest in the world, according to a 2014 announcement by the Jordanian Minstry for Water and Irrigation.[3] Increased temperatures and worsening drought[4] will affect Jordan's food production and security, the availability of water for human consumption and industrial purposes, and the stability and sustainability of ecosystems. Impacts on areas such as energy production and national security are also plausible, although the causal chain is less direct.

Prioritising climate change adaptation is thus a vital, and arguably inseparable, step in realising development goals such as poverty reduction, improving infrastructure and reducing environmental risks.[5]

This paper offers a detailed case study of the capacity of one rural Jordanian community to adapt to the immediate and projected impacts of climate change. It describes the measures that farmers have taken to adapt to worsening drought and heat, why these attempts have thus far been limited, and provides suggestions as to the kinds of policy changes needed to incentivise change. The information gleaned also provides important insights into cost-effective and time-efficient means of better understanding climate change challenges, vulnerability variations between communities and potential avenues for adaptation. Indeed, any exercise in adaptation will need to be locally-driven and align with local interests in order to be effective. The data collection tools employed in this research empowered community members to critically assess the changes taking place in their communities and reflect upon the impacts on their livelihoods. The tools thus represent a framework with strong upscale potential to be considered by policy-makers as the process begins to implement both the Sustainable Development Goals (2015) and the Paris Agreement (2016).

---

[1] USAID, *Climate-resilient development: a framework for understanding and addressing climate change* (Washington: 2014)
[2] "About Jordan," United Nations Development Programme, accessed October, 2016, http://www.jo.undp.org/content/jordan/en/home/countryinfo.html
[3] Hana Namrouqa, "Jordan world's second water-poorest country," *Jordan Times,* October 22, 2014, accessed September 19, 2016, http://www.jordantimes.com/news/local/jordan-world%E2%80%99s-second-water-poorest-country; "World Water Resources by Country," FAO, accessed October 24, 2016, http://www.fao.org/docrep/005/y4473e/y4473e08.htm
[4] UN-Water, *Climate change adaptation: the Pivotal Role of Water*, Policy Brief (2010)
[5] Mohan Munasinghe and Rob Swart, *Primer on Climate Change and Sustainable Development: Facts, Policy Analysis, and Applications,* (Cambridge University Press, 2005)

1. Climate Change Vulnerability and Adaptation

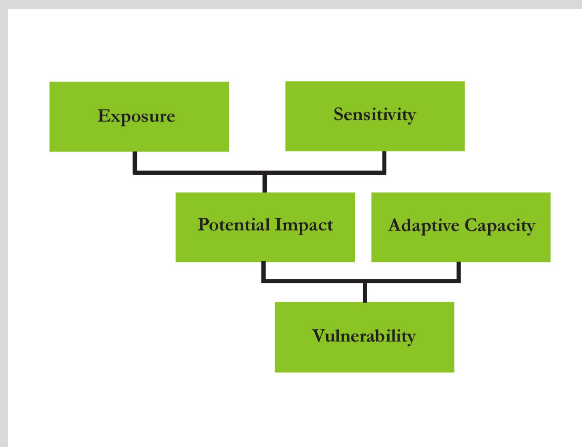
Adapting to climate change cannot replace measures at a global level to reduce greenhouse gas emissions. However, it is now broadly accepted that mitigation measures will not prevent at least some significant climate change over the coming century.[6] As the most recent report by the Intergovernmental Panel on Climate Change (IPCC) makes clear, even with drastic cuts in greenhouse gas emissions over the next 20-25 years, falling to almost zero by the end of the century, it is — at best — as likely as not that the planet will see a 1.5 degrees increase in temprature. If the international community falls short of such ambitious goals, substantially greater amounts of warming can be expected.[7] As such, "adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change."[8]

Climate change vulnerability is defined by the IPCC as "the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability."[9] IPCC understands vulnerability as an interplay of three main factors: exposure, sensitivity and adaptive capacity (Box 2). The aim of increased adaptative capacities is thus to decrease climate change vulnerability and create more resilient societies.

Box 2 [10]

In the report *Understanding Vulnerability to Climate Change,* CARE International's Poverty Environment and Climate Change Network (PECCN) proposed an analysis of vulnerability based on IPCC on the following three variables:[11]

- **Exposure (to climate variability and change)** concerns the degree of climate variability that a system experiences; it may be represented as either long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events.
- **Sensitivity (to climate stress)** is the degree to which a system will be affected by, or impacted by climate change.
- **Adaptive Capacity** means the potential or capability of a system to adjust to climate change, including climate variability and extremes, so as to moderate potential damage, to take advantage of opportunities, or to cope with consequences.



[6] The UNEP defines climate change mitigation as "efforts to reduce or prevent emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior." see "Climate Change Mitigation," UNEP, Accessed October, 2016, http://www.unep.org/climatechange/mitigation/

[7] IPCC, *Climate Change 2014: Synthesis Report for Policymakers*, pp 20-21. Accessed November 2016

[8] ibid. p17

[9] See generally: "Conceptual framework for the identification and assessment of key vulnerabilities," IPCC, Accessed October, 2016, https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch19s19-1-2.html

[10] Image adapted from: P. Glick and B. Stein, *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessments,* (Washington: National Wildlife Federation, 2011)

[11] Angie Dazé, *Understanding Vulnerability to Climate Change: Insights from application of CARE's Climate Vulnerability and Capacity Analysis (CVCA) Methodology* (Care Poverty PECCN, 2011)

This framework does not enjoy universal consensus. Some argue that it overlooks important factors such as socio-economic resilience, poverty and conflict.[12] Indeed, research has shown that climate change vulnerability and impacts are diverse, locally specific, long term and difficult to predict.[13] This makes assessing a community's vulnerability to climate change impacts a complex and imperfect procedure. It is thus with acknowledgment of its limitations that this report adopts the IPCC vulnerability framework as an heuristic tool for assessing the adaptive capacity of a local community to climate change impacts.

As the framework sets out to reduce vulnerability it is necessary to decrease one of its driving factors. But while interventions to reduce sensitivity or to increase adaptive capacity are possible, a system's exposure is fixed. For example, if a local community has only one water resource available for agriculture, it will be highly *sensitive* to the impacts of climate change in the form of water shortages. Adaptation measures such as integrated water resources management and the introduction of water saving technologies will reduce such a community's overall sensitivity, and hence its vulnerability. A local community that lacks knowledge about climate change and is dependent on one means of income generation (e.g. agriculture), will have a low *adaptive capacity*, which means that its overall vulnerability will be higher. Here, by contrast, it is the community's adaptive capacity that should be augmented to help decrease its overall vulnerability.

Seeking to reduce climate change vulnerability and promote adaptation might well seem to be two sides of the same coin. However, climate change adaptation interventions produced in developing countries can sometimes actually increase community vulnerability. This usually happens when policy decisions lead to incentives that encourage communities to continue activities that made them vulnerable in the first place.[14] For example, digging an extra well — and thereby over-extracting groundwater — to cope with drought represents a form of adaptation. However if doing so means that a community will forego measures aimed at better conserving water or developing other income streams, then the community's overall vulnerability will have increased.

In summary, interventions aimed at augmenting adaptive capacity should be tailored to the needs of local communities; providing top-down assistance is not enough. If communities are to become truly resilient in the face of climate change, they must be supported to adapt to future as well as immediate crises, and to unexpected crises as well as relatively predictable ones. To do this, communities must be empowered to make well-informed decisions, have access to information and technologies, and be connected to a variety of income streams and markets.

There is a pressing need to assess what such a path would look like in a country like Jordan. The purpose of this paper is to provide an empirically-grounded starting point for answering this

---

[12] Maximillian Ashwill, Cornelia Flora and Jan Flora, *Building Community Resilience to Climate Change: Testing the Adaptation Coalition Framework in Latin America* (The World Bank, 2011)
[13] ibid.
[14] ibid.

question. It focuses on understanding the situated realities of adaptive capacity in a climate change affected agricultural community. By assessing the extent of adaptation, as well as the limitations therein, it seeks to highlight the points at which policy interventions could incentivise agricultural communities to build their adaptive capacity.[15]

2. Methodology

The case study for this research was selected through a brainstorming exercise enagaging local practitioner experts and academics. The site selected — Sabha in the Northern Badia of Jordan — was identified as representative of a highly vulnerable community in Jordan, but one that was reasonably accessible (70km away from Amman) and not the subject of a previous climate change assessment.

A desk-based literature review was then conducted to isolate the five principal requirements for adaptive capacity. For each requirement, a numerical ranking system was created, along with heuristic descriptions to guide rank assignment.[16] The requirements and ranking systems is set out in tables 1 and 2 below.

Two data collection tools were employed in this research — the Participatory Rural Appraisal (PRA), and the Community-based Risk Screening Tool–Adaptation and Livelihoods (CRiSTAL). In contrast to more traditional forms of qualitative research, PRA is a research tool specifically premised on the idea that "a local community (with or without the assistance of outsiders) studies an issue that concerns the population, prioritises problems, and evaluates options for solving the problem(s)."[17] It is a combination of approaches that enable a local community to share, enhance and analyse its knowledge of the current situation, and assume an active role in analysing their own living conditions, problems and potential in order to create positive change. A PRA is also a fast way to collect data that connects socio-economic and environmental interests, and establishes a framework for responding to local community needs and priorities. Most PRAs last from three to five days and the data collection tools are designed by a multidisciplinary and gender-balanced team composed of both community and non-community members.[18] Other distinctive features of the method include that community members go on to collect the data — an important factor in promoting local ownership over the results — and that the analytics are done jointly by the PRA team and local facilitators.

CRiSTAL offered strong complementarities to the PRA approach. CRiSTAL is a project planning tool that helps users design activities that support community-level climate adaptation. Specifically, it

---

[15] The approach taken in this paper is similar to that in Ibrahim and Ward, *Promoting Local Adaptive Capacity*. However, none of the cases featured in this report concerns a country in the WANA region

[16] These criteria are based and built on: Ibrahim and Ward, *Promoting Local Adaptive Capacity* and UNFCCC, *Jordan's Third National Communication on Climate Change* (Jordan: 2014)

[17] "Appendix - 1. Participatory rural appraisal tools that may be useful in an institutional analysis," FAO, accessed November, 2016, http://www.fao.org/docrep/w7483e/w7483e0a.htm

[18] "Conducting a PRA Training and Modifying PRA Tools to Your Needs" FAO, accessed June 2016, http://www.fao.org/docrep/003/x5996e/x5996e06.htm

helps prioritise climate change risks and identify resources that are most affected by climate change.[19] CRiSTAL relies on information collected from desk-based research and local stakeholder consultations (community members and other local experts) using participatory workshops and focus group discussions.

Given that the purpose of the research was to both understand a community's adaptivity to climate impacts, and help it to address the challenges faced, the PRA and CRiSTAL had obvious merits. Additionally, community facilitators had previously been trained by other international organisations in using the tools. The output from these tools was data collected through 100 interviews with community members.

Table 1: Principal Requirements for Adaptive Capacity	
Information and knowledge	A community must have access to information to make the best use of its resources in the event of new climatic conditions, as well as to local knowledge on how the climate is changing and the impacts of this for livelihoods and resource sustainability. A community, for example, might use climatic data to make an informed selection of agricultural activities, or use temperature and weather data to make decisions on when to cover and protect crops during frost seasons.
Innovation	Information and knowledge can only foster an increase in adaptive capacity if a community is prepared to devise new practices suitable to changed conditions. Innovation in this context thus means being able to use data and local knowledge to make necessary changes in the system to cope with climate change.
Community leadership and organisation	Community leadership and organisation concerns whether a local community can work together to advocate for its rights and/or find new ways to solve their problems. A key indicator will be whether there are strong and active community-based organisations (CBOs) with channels of communication with relevant government authorities in the area. Ideally, CBOs cooperate with each other and work together with governmental authorities to empower locals to adopt adaptive measures.
Access to subsidies and emergency assistance	In severe climatic conditions, extra services and resources given can drastically increase the adaptive capacity of a local community. These might include the provision of extra fodder or subsidised water to livestock owners during drought.
Income diversity	Diversity in income streams is key to reducing vulnerability. A community that is largely or wholly dependent on one form of economic activity, a single form of agriculture, or on a single crop is poorly placed to cope with hazards resulting from climate change compared to one with diversified sources of income.

[19] *CRiSTAL User's Manual – Version 5: Community-based Risk Screening Tool – Adaptation and Livelihoods* (Canada: The International Institute for Sustainable Development, 2012), 8-9

Table 2: Assessing the Adaptive Capacity of a Local Community				
Adaptive capacity factors	**Low** **1**	**Slight** **2**	**Moderate** **3**	**Good** **4**
Information and knowledge	Local community has low awareness of climate change and its impacts on their natural resources; no climatic and environmental data available for the geographic area	Local community is aware of climate change but has little to no knowledge regarding its impacts on their resources; climatic and environmental data is available but is not easily accessible	Local community is aware of climate change impacts on its natural resources; climatic and environmental data is available, however, the local community has little knowledge regarding its use and interpretation	Local community has acces to all data and possesses the knowledge required to manage their resources in the face of climate change impacts, with help from relevant directorates
Innovation	Climatic and environmental data is unavailable, local communities do not find ways to adapt	Climatic and environmental data is available, local communities do not find ways to adapt	Climatic and environmental data is available, local communities use subsidies and compentation to adapt	Climatic and environmental data is available, local communities not only use subsidies and compentation but create new ways to adapt
Community leadership and oragnisation	No CBOs or community leaders and no affiliations to government institutions	CBOs are present but inactive	CBOs are active in advocacy and adaptive measures	CBOs cooperate and work together with governmental authorities in empowering locals with adaptive measures
Access to subsidies and emergency assistance	Access to subsidies during extreme climatic conditions	Access to compensation during extreme climatic conditions	Access to compensations and subsidies during extreme climatic conditions	Access to extra governmental services during extreme climatic conditions through a systematic, efficient and reliable insurance service
Income diversity	The community depends on one major source of income that is sensitive to climate change	The community depends on different sources of income that are sensitive to climate change	The community depends on a variety of resources of income, that are both sensitive and non-sensitive to climate change	The community depends on different sources of income that are not immediately sensitive to climate change

3. Climate Change in Jordan

Jordan is a resource poor, middle-income country facing a set of complex developmental challenges and turbulent regional geopolitics.[20] Geographically, the Kingdom is almost entirely semi arid or arid. Ninety percent of governorates receive an annual rainfall of less than 200mm.[21] Inefficient agricultural practices use more than half of the nation's water while generating less than 10 percent of GDP.[22] With only 147 CM/per person/day and a renewable water supply of 130 CM/per person/day, current use exceeds the renewable supply of water. As a result, Jordan is digging into non-renewable aquifer sources. If the supply remains constant, per capita domestic consumption is projected to fall to 90 CM per/person/day by 2025.[23]

Climate change is expected to have varied impacts on Jordan. Historical meteorological data collected from points throughout the country indicate that annual precipitation is now decreasing at a rate of 1.2mm per year, while temperatures are increasing by at least 0.03 degrees per year.[24] Using dynamical downscaling (a statistical technique which makes it possible to use large-scale models to make local-scale predictions), it has been predicted to be extremely likely that Jordan will see warmer summers and a generally drier climate. Predictions regarding Jordan's weather patterns have likewise concluded that drought events will become more likely with longer periods of consecutive dry days.[25]

In response to these threats, governorates and municipalities provide extra governmental services free of charge or at a subsidised rate to communities that have suffered climate change impacts such as drought and frost. These might include the provision of extra fodder or subsidised water to livestock owners. Another mechanism is the Agricultural Risk Management Fund, an emergency response fund managed by the Ministry of Agriculture, which provides financial compensation for drought damage incurred by farms. A committee is responsible for calculating the degree of damage, and compensation is given accordingly.

Subsidies and compensation along these lines help communities in immediate and practical ways. However insofar as such practices reward and sustain practices that are, almost by definition, an inefficient use of resources, a strong case can be made that they do more harm than good. For example, farmers who receive subsidised water will be disincentivised from developing more water-efficient ways of obtaining the same yield, or developing alternative income streams.[26]

This raises a difficult series of policy choices. In the long term, state policies aimed at fostering growth in adaptive capacity will presumably have to shift to an incentive structure that rewards

[20] Ministry of Water and Irrigation, *Jordan National Water Strategy 2016-2025* (Amman, 2016)
[21] ibid.
[22] UNFCCC, *Jordan's Third National Communication on Climate Change* (Jordan: 2014),109
[23] ibid, 14
[24] UNFCCC, *Jordan's Third National Communication on Climate Change: Executive Summery* (Jordan: 2014),17
[25] Ibid, 19
[26] See e.g. David Pearce and Donata Finch, "Advancing Subsidy Reform: Towards a Viable Policy Package" in *Finance for Sustainable Development: Testing New Policy Approaches*, United Nations Development of Economic and Social Affairs (New York: United Nations, 2002), 181

positive innovation, rather than risk-averse conservatism. However, the process of shifting away from familiar subsidy structures is unlikely to be popular among poor communities more concerned with immediate need than long-term planning.

This paper proposes that one way to transition towards an incentive structure that encourages communities to adopt innovations that reduce their longer-term vulnerability to climate change, is for state aid to be delivered in the model of an insurance scheme. Where such schemes cushion farmers from real market costs, they can provide a flexible and light-footed form of support. This allows for the possibility of "redesign[ing] products not merely as a risk transfer mechanism, but as a potent device to reduce risk and crop loss by inducing desirable proactive and reactive responses in insurance users".[27]

Box 2: Climate Change Impacts in Jordan[28]

In 2014, Jordan submitted its *Third National Communication on Climate Change*, in line with the requirements of the United Nations' Framework Convention on Climate Change (UNFCCC). Based on rigorous analysis, the report sets out what Jordan's future climate can be expected to be like under different emissions scenarios explored by the IPCC.

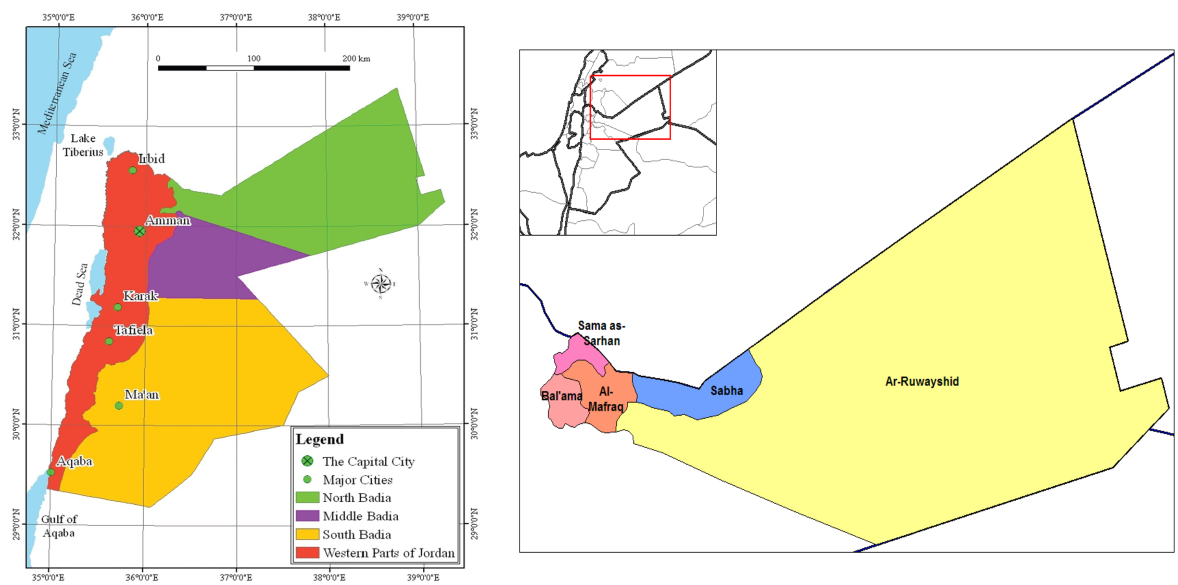
- It is *extremely likely* that Jordan's climate will be significantly hotter by 2085. A lower-end emissions scenario is expected to lead to a temperature increase of more than 2.1 degrees, while a higher emissions scenario will lead to a temperature rise of more than 4 degrees.
- In 2070-2100, total yearly precipitation will *likely* decrease between 15 and 21 percent.
- Jordan is *likely* to have drier autumns and winters, with a median value of precipitation decrease reaching 35 percent in autumn between 2070-2100.
- It is *extremely likely* that Jordan will face an increase in heat waves in which temperatures will reach more than 44 degrees centigrade.
- From 2070-2100 it is *likely* that Jordan will face increased incidence of drought (more than 30 consecutive dry days).
- Despite this increase in overall temperature, Jordan is not expecting a decrease in snowfall. Overall preparations will need to be made for significant variability in Jordan's weather.

[27] Mamata Swain, *Crop Insurance For Adaptation To Climate Change In India* (London: Asia Research Centre Working Paper, 2016)
[28] UNFCCC, *Jordan's Third National Communication on Climate Change*

4. Sabha, Al Mafraq Governorate – Study Area

Administratively, the Mafraq Governorate is divided into three districts — Ruwayshid, Northern Badia, and Northwest Badia, and into seven sub-districts — Sama As-Sarhan, Hosha, Dair Al-Kahf, Sabha, Um al Jimal, Um Al-Quttain and Al-Khaldiyah (figure 1). The local community of Sabha, alongside six sister villages, belongs to the sub-district of Sabha which sits 35 km east of Al Mafraq city.

Figure 1: Mafraq Governorate[29]



The settlement of Sabha is the most populous in its sub-district, with a natural range of cultivable land suitable for improved agriculture and livestock production.[30] Nonetheless, the area faces challenges including under-employment, employment in unproductive activity and limited income diversity. Moreover, excessive drought seasons and regular overgrazing have contributed significantly to land degradation.[31]

The community of Sabha, like many communities in the Jordan Badia, is highly dependent on agriculture and animal husbandry for its livelihood, along with public sector employment. Agricultural activities include the production of fruit, vegetables, wheat and barley.[32] Livestock production is also an essential part of the local community's income with an estimated 12,500 head of sheep and goats grazing in the area.[33] These activities are highly sensitive to climate change

[29] Abu Sada, Abu-Allaban and Al-Malabeh, "Temporal and Spatial Analysis of Climate Change"
[30] Alaa Abu Sada, Mahmoud Abu-Allaban and Ahmad Al-Malabeh, "Temporal and Spatial Analysis of Climate Change at Northern Jordanian Badia," *Jordan Journal of Earth and Environmental Sciences* 7 (2015): 87 - 93
[31] "The Jordan Badia," The Hashamite Fund for Development for Jordan Badia, accessed September, 2016, http://www.badiafund.gov.jo/en/node/310
[32] Based on data collected through the PRA conducted for this area by the WANA Institute.
[33] Based on an interview with "The Veterinary Department of the Northern Badia Agricultural Directorate"

impacts, including temperature increase, rainfall decrease, drought and changes in the arrival of the rainy season.[34]

4.1 Water and Wastewater Networks

In Sabha, the municipal water supply network covers almost all areas of the village. This supply, however, is intermittent and limited to only once a week for each household. Interruptions significantly increase in periods of high water demand such as the summer and drought seasons. During these periods, families may receive running water only once every three weeks. Moreover, the water supply network in the area is old and dilapidated, leading to high levels of water loss and reduced water quality.[35]

A major environmental challenge is that the area is not connected to the municipal sewage system, forcing people to use on-site sanitation solutions such as septic tanks or holes, which in many cases do not meet environmental and health standards and/or are not repaired regularly. The absence of well-aligned and regularly maintained septic tanks poses significant environmental and health hazards. Such systems can malfunction, potentially causing the contamination of soil and groundwater resources in addition to sewage-borne diseases.

4.2 Groundwater

Sabha is situated on the Zarqa River Basin (ZRB), the second main tributary to the River Jordan after the Yarmouk River, and one of the most depleted basins in Jordan. The total water used for agriculture from the ZRB is estimated at 166.3 MCM per year. Climate change modeling and prediction scenarios suggest that if the temperature increases by 1 degree celcius, total agricultural production will decrease by 3.5 percent, and water consumption will increase by 3.8 percent.[36] This is particularly significant for Sabha; groundwater resources are the cornerstone of agricultural production[37] and most rainfed agriculture cannot survive in areas with precipitation of less than 200mm per year.

With decreasing annual agricultural production (driven by decreased water availability) locals are expanding their cultivated areas. Producing crops on open fields, however, is even less efficient and known to require more water in order to produce good quality crops. Interviewees noted that a number of illegal wells are still operational, and unsustainable agricultural techniques such as flood irrigation are frequently employed.[38] Locals also pump extra water from licensed wells according to the season; they store unused water in winter (using artificial lakes) for use in the summer, further depleting the aquifer and limiting its capacity for natural replenishment.

---

[34] UNFCCC, *Jordan's Third National Communication on Climate Change*
[35] Based on data collected through the PRA conducted for this area by the WANA Institute
[36] UNDP, *Assessment of Direct and Indirect Impacts of Climate Change Scenarios – Climate Change Adaptation In The ZRB* (Jordan, 2013), 6
[37] Based on data collected through the PRA
[38] Based on data collected through CRiSTAL conducted for this area by the WANA Institute

5. Assessing the Adaptive Capacity of Sabha

As noted, CRiSTAL and PRA data collected through 100 community interviews were used to qualitatively assess Sabha's climate change adaptive capacity. It was found that the local community faces three major climate change impacts; frost, drought and an increase in temperature. For analytical purposes, drought and increases in termperature were combined as they produce similar effects.

- **Drought and increases in temperature:** Droughts are periods when precipitation falls well below the yearly average, in the case of Sabha, less than 150mm per year. As well as directly affecting crop production, drought can also result in a longer-term decrease in soil moisture, which in turn decreases crop quality.[39] A decrease in urban water supply, where households do not have available water for periods of a week or more, is also considered to be drought.[40] Increases in temperature, which can occur independently from drought, can result in crops needing more water than anticipated, or water demand exceeding structural supply capability.

- **Frost**: During Jordanian winters, temperatures can drop unexpectedly overnight (and sometimes for a small period of time thereafter) to below zero, affecting both agriculture and vegetative cover for grazing.[41] As it cannot be scientifically verified, classifying frost as a climate change impact may seem controversial. However, during interviews locals repeatedly relayed their experience of incidences of sudden and unexpected frost becoming more common over the past 20-30 years — a development that they are struggling to cope with.

Figures 2 and 3 below illustrate diagramatically the results generated when the ranking system developed for this research was applied to analyse the communtiy's adaptive capacity to increased temperature-drought and frost. With respect to increased temperature-drought it is clear that while the community is strong in knowledge and innovation, its overall adaptation capacity is limited by its weak community organisation and leadership, dependence on agriculture, and particularly its lack of access to subsidies and emergency assistance. Adaptive capacity during times of frost was relatively stronger, due to higher innovation and access to assistance, and a lower impact from income diversity.[42] The specific areas of investigation are discussed in further detail below.

[39] There is no set definition for drought, but the Normalized Difference Vegetation Index – NDVI is used by researchers to monitor drought in Jordan. "The Drought Warning Unit," NCARE, accessed September 04, 2016, http://www.ncare.gov.jo/body.aspx?id=271. The NDVI is a way to determine the density of green on a patch of land, and observe the distinct colors (wavelengths) of visible and near-infrared sunlight reflected by the plants. "Normalized Difference Vegetation Index (NDVI)," NASA. Accessed September 05, 2016, http://earthobservatory.nasa.gov/Features/MeasuringVegetation/

[40] A decrease in urban water supply turns water to a scarcer commodity which can be bought from private well owners

[41] The critical temperatures needed for damage to occur may vary depending on the duration that temperatures remain below freezing. For example, buds of fruit trees may be damaged if exposed to -2°C for more than 24 hours, but may survive if exposed to -6°C for less than 2 hours. Thus the critical temperature for a radiative frost lasting for only a few hours in the early morning may be lower than that of frost which may continue over night and some daytime hours. "Freeze Protection Methods for Crops," Ministry of Agriculture, Food and Rural Affairs in Ontario, CA. Accessed October 04, 2016, http://www.omafra.gov.on.ca/english/crops/facts/85-116.htm

[42] It was originally hypothesized that the local community find it hard to adapt to frost conditions, specially farmers who have lost financially in the past

Figure 2: Adaptive Capacity Against Increases in Temperature and Drought

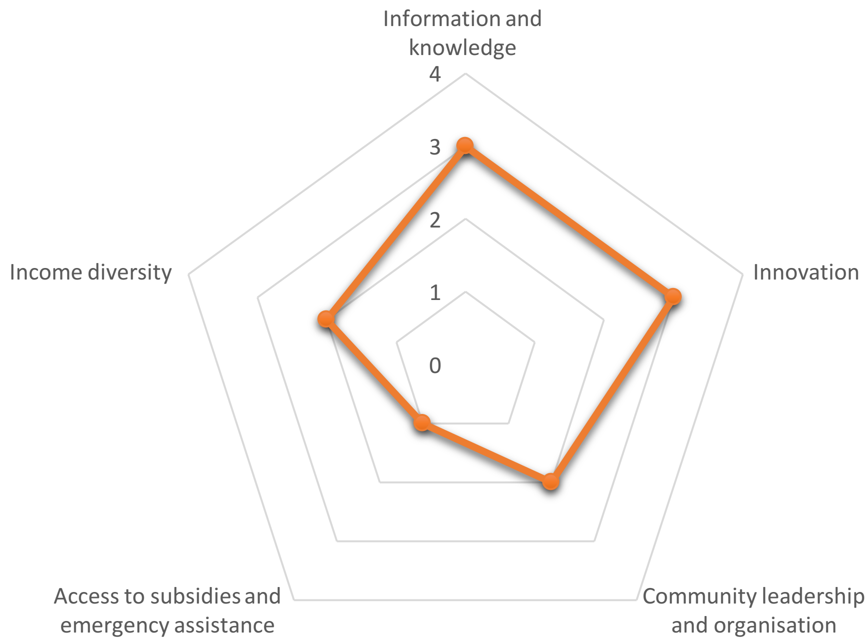


Figure 3: Adaptive Capacity Against Frost

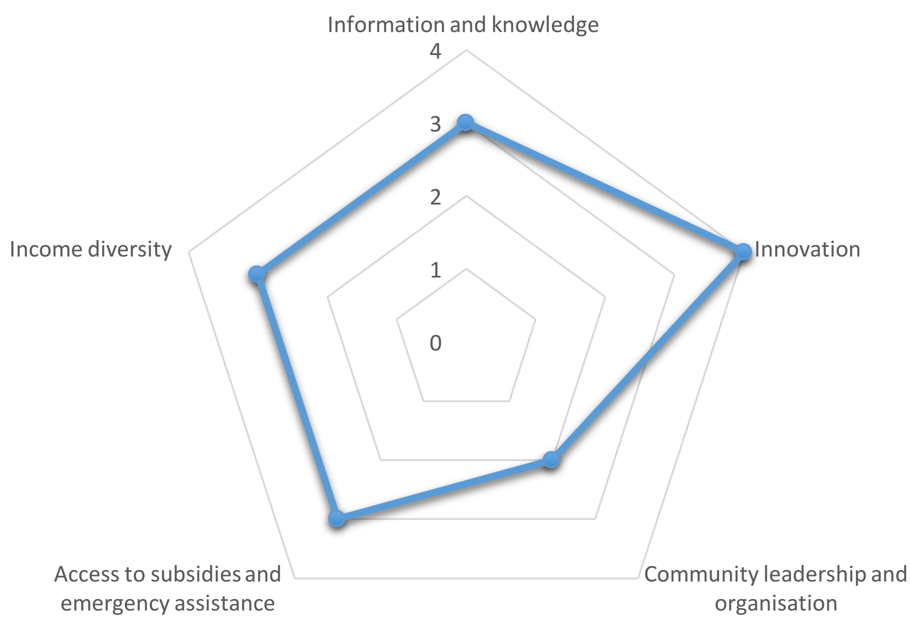


Table 3: Assessing the Adaptive Capacity of Sabha		
	Increased temperatures and drought	**Frost**
Information and knowledge	Information about local climatic changes such as precipitation data is freely available and accessible from governmental directorates.[43] Obtaining this information, however, is quite difficult due to the scattered nature of villages and inefficient transportation services. A further challenge is that information is provided with minimal explanation, creating a risk of misinterpretation. This informational deficit may help to explain why farmers are still producing barley and wheat, despite evidence pointing to higher temperatures and lower precipitation, and thus lower quality annual yields. Perhaps the most useful tool for planning climate change adaptation stratgeies is the database at the National Centre for Agricultural Research and Extension (NCARE) drought monitoring unit; locals, however, did not appear to be aware of this. While community members may not understand the specific scientific reasons behind the changes in temperature and increased incidence of drought, they do understand that these changes affect their crop production and sources of income. Specifically, they have observed that over time the maturity and quality of crops has declined, incidences of livestock disease and death have increased, and some species of medicinal plants are dying out.	Information pertaining to frost is advanced in Jordan. Information is freely available from local area directorates and television weather forecast broadcasts. Such news warns farmers about frost possibilities at least two days in advance and provides adaption options. Over the years, farmers and livestock owners have observed the impacts of frost and are aware of the consequenecs on their livelihoods. However, farmers do not always use this information to their benefit. Over the years, many warnings have been issued and a lot of the farmers decided to disregard this information, hoping for the slight chance that it might not occur.
Innovation	Despite observable impacts, there is little evidence of contingency planning or innovation to cope with changing conditions. Farmers still cultivate wheat and barley in affected areas, resulting in a massive increase in irrigation to maintain quality[44] and increased use of pesticides.[45] Only a small	In response to frost conditions, farmers have introduced various techniques, including covering important fruit trees with plastic or mesh, or burning tyres to increase the humidity and temperature around their farms. Burning tyres also covers plants with a thin layer of tar which, while environmentally damaging,

[43] The department of statistics in Jordan (DOS) produces data about precipitation yearly which is available free of charge online, if locals do not have access to the internet, more detailed information can be available from the Directorate of the North-East Badia – Ministry of Agriculture in the Mafraq Governorate. The National Agricultural Information System (NAIS) is also available free of charge online at http://www.nais-jordan.gov.jo

[44] Land and water scarcity are major constraints to the production of food required to meet the quantitative and qualitative demands. Wheat and Barley are huge consumers of water, which then need more water to produce more mass in higher temperatures. The physical water productivity of wheat in that area is high, which is defined as the ratio of mass of product to the amount of water consumed ('more crop per drop'). Victor O Sadras, Patricio Grassini and Pasquale Steduto, *Status of Water Use Efficiency of Main Crops*: *SOLAW Background Thematic Report - TR07*. FAO, Accessed October 2, 2016, http://www.fao.org/fileadmin/templates/solaw/files/thematic_reports/TR_07_web.pdf

[45] Locals tend to use more pesticides than usual to combat pests that increase in dry, hot weather. Based on data collected through the PRA

	number of farmers have adopted greenhouse farming.	decreases the possibility of freezing. One reason preventing adaptation appeared to be lack of financial capacity.
Community leadership and oragnisation	Sabha is home to only four CBOs, none of which are engaged in information dissemination and/or capacity building around climate change adaptation.	
Access to subsidies and emergency assistance	The government (through the Agricultural Risk Management Fund) does not provide financial compensation for damage caused by drought. Livestock owners (although not arable farmers) can purchase water at a subsidised rate of 4-6 JODs per 6m³ tank all year round through the Ministry of Agriculture.[46] It is important to highlight that during drought periods, community members can also purchase extra water from non-government sources. Such water can be purchased for 20-35 JOD per 6m³ tank during normal times, but this can increase to 50 JOD during drought.[47]	The Agricultural Risk Fund provides financial compensation for frost-damage to crops based on a per dunum loss calculation.[48] In 2016, the fund provided compensation of over 50 percent if the damage was to uncovered vegetables, medicinal plants and fruit trees, and 30 percent in the case of covered vegetables.[49] It is noteworthy that during one frost incident in 2015, no compensation was paid because the government issued a frost warning along with proper precautionary measures.[50]
Income diversity	All income generating activities are affected by drought and an increase in temperature. Farmers face decline in the quality of their crops. Livestock owners may have little to no land or water on which to graze and water their livestock.[51] Even people employed by the government will tend to pay a higher part of their wages on energy used for air-conditioning and fans. Therefore, even those members of the local community whose income is not directly affected by climate-change impacts are likely to remain poorer as a result of expenditures that these impacts force on them.	Income generated from arable farming is highly affected by frost. Farmers can lose a large area of crop overnight worth thousands of JODs. However, income generated from raising livestock is not sensitive to frost since farmers shelter their livestock during winter. Additionally, livestock in this area mostly rely on fodder and are less dependent on natural vegetation which could be lost during frost.

[46] Based on an interview with officials from the Agricultural Directorate in the Northen Badia

[47] Based on data collected through the PRA

[48] In 2015, the Lower House approved the Senate's amendments to the 2015 law on the Agricultural Risk Management Fund, confining compensation paid to farmers in case of natural disaster only to frost. Raed Omari, "MPs approve Senate's version of bill on agricultural fund" *The Jordan Times*, August 25, 2015, accessed September, 2016, http://www.jordantimes.com/news/local/mps-approve-senate%E2%80%99s-version-bill-agricultural-fund

[49] "Jordan: Compensation for Farmers Affected by Frost." Zeraiah.net, February, 2016, accessed October, 2016, http://www.zeraiah.net/index.php/home/news/17964-2016-02-02-20-20-35

[50] "No compensation for those affected by frost yet," Al Rai Newspeper, 2015, Accessed October, 2016, http://www.jordanzad.com/print.php?id=5389

[51] Livestock owners graze their livestock in areas that are not close to the villages because of urbanization and the increase in agricultural lands. The natural vegetative cover is dry in surrounding areas, and therefore livestock relies on fodder

6. Conclusion: Moving Towards More Resilient and Adaptive Societies

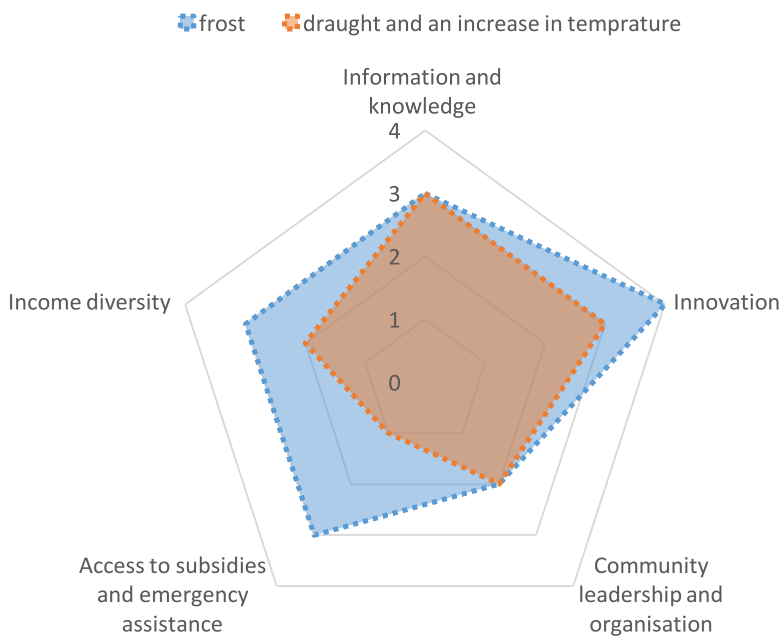
This research demonstrated that the adaptive capacity of a specific local community was better in responding to frost than it was to drought and increasing temperatures (figure 4). This could be due to the fact that frost is easier to adapt to by applying simple mitigation measures, and that it occurs less frequently than drought in Jordan. A key deficit identified was that despite having access to sufficient data and knowledge, the behaviour of local community members has not changed with regard to agriculture and livestock grazing. Moreover, farmers in Sabha rely on agriculture and livestock for income and show reluctance to develop new income streams. A final deficit was in community leadership; CBOs can advocate for community rights, be hubs for capacity building and provide linkages with government institutions. Such leadership on climate change is presently lacking in Sabha; a situation that will not change as long as subsidy and compensation arrangements are present.

It is clear that better ways to adapt to climate change conditions need to be found, including through measures designed to promote the uptake of adaptive technologies. Appropriate drought adaptation measures include building rainwater harvesting systems, planting drought-resistant crops and crop contingency planning. Drought early warning systems and drought relief plans can also play a vital role in adaptation. Innovative adaption might also include engaging in divergent activities that are less sensitive to climate change (but not necessarily a phasing out of agriculture or livestock). In the course of interviews, it became apparent that locals were aware of such adaptive measures. When asked why they were not implementing these solutions, the reason given was routinely insufficient financial resources.

The government has implemented schemes for providing financial support to farmers suffering from damaged crops — albeit to a limited and variable extent — in the form of compensation or subsidies. While important from an immediate poverty-avoidance perspective, such measures tend to support existing (and vulnerable) farming practices. Moroever, community members complained about the inconsistency of these compensation payments, and did not seem to regard government support as a potential mechanism for helping them adopt practices better suited to future climatic conditions. This underscores the importance of measures that target local communities' motivation to become more resilient.

One modality is to move away from compensation and subsidies and towards a form of government-backed insurance. Such a model would subsidise insurance packages specifically tailored to the needs of livestock owners and farmers experiencing extreme climatic episodes. They might reward efforts taken towards adaptive capacity by linking pay-outs to certain adaptive conditions having been met, such as frost protection, rain water harvesting systems, or drought and frost resistant crops. Compensation for fodder should be phased out in favour of incentives to find ways to regenerate natural vegetative cover for grazing. The creation of new *Himas*[52] is one arrangement that might achieve this.

Figure 4: The Adaptive Capacity of the Local Community During Frost and Drought Compared



Ultimately, understanding the factors that underpin the communities' ability to adapt to climate change is immaterial without commitment to action. Such action must emminate from communities themselves. The research reported in this paper indicates that what rural Jordanians need in order to become better adapted to climate change is not so much new knowledge or skills, as new incentives and better leadership in the form of strengthened local organisations. Only by tackling this problem, will Jordan — as it must — become a more resilient society.

[52] The word *hima* means "protection" and refers to an area set aside for conservation. Today it is generally understood as a traditional community system of land management to organise grazing and protect lands

WANA
INSTITUTE

Royal Scientific Society, 70 Ahmad Al-Tarawneh St, Amman, Jordan | Tel: +962 6 534 4701 | info@wanainstitute.org
www.wanainstitute.org