Integrating climate change adaptation into development planning

A practice-oriented training based on an OECD Policy Guidance

Training Manual

giz Climate Protection Programme

On behalf of
Federal Ministry for Economic Cooperation and Development

The training course and associated materials are based on an OECD Policy Guidance “Integrating Climate Change Adaptation into Development Co-operation”, published in May 2009. They were generously funded by the **German Federal Ministry for Economic Cooperation and Development (BMZ) and developed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH** in coordination with OECD and a broad range of reviewers from development agencies, NGOs and research institutions from around the world. The authors gratefully acknowledge the valuable feedback contributed by reviewers and training participants.

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GIZ's Climate Protection Programme helps developing countries to adapt efficiently and appropriately to changed climatic conditions. Working together with our partners, we identify the options for action with regard to affected people, economic sectors and ecosystems.

The key task of the Climate Protection Programme is to mainstream climate protection within the various activities of German Development Cooperation. This applies both to reducing greenhouse gas emissions and to measures to adapt to climate change.

These tasks, however, cannot be successfully tackled by climate protection experts alone. The Climate Protection Programme can therefore only work effectively if it is integrated into the networks of development cooperation and globally organised climate protection, and collaborates with national and international partners.

http://www.gtz.de/climate

Have you carried out or participated in the training? If yes, we would appreciate hearing from you! Please send your feedback (who organised the training? who participated in the training? how did you find it? What worked and what did not?) to climate@giz.de.

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Introduction to the course

Adapting to climate change is a rapidly growing challenge, particularly for developing countries. Even if greenhouse gas emissions are reduced significantly in the coming years, climate change impacts, such as gradual temporal and spatial shifts in resources as well as drought, floods, severe weather events and sea-level rise, are likely to result in food shortages, increases in vector-borne diseases, infrastructure damage and the degradation of natural resources. The poor will be affected disproportionately.

Development choices today influence the adaptive capacity of people and their governments well into the future. We cannot afford to delay adaptation planning and action. However, many development policies, plans and projects currently do not take climate change into account due to a lack of awareness and clarity on how to effectively develop and integrate adaptation options.

Integrating adaptation into development cooperation provides an essential opportunity to make more climate-resilient development investments. OECD's Environment Policy Committee (EPOC) and its Development Assistance Committee (DAC) therefore developed the *Policy Guidance on Integrating Climate Change Adaptation into Development Co-operation*[1] (OECD Guidance) with the aim of promoting understanding and identifying appropriate approaches and practical ways for integrating climate adaptation into development policies and activities at national, sectoral, project and local levels.

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, in close coordination with the OECD, developed this training course and associated materials based on their involvement in the OECD Guidance, extensive adaptation activities on the ground in developing countries, and the GIZ tools for mainstreaming climate change into development cooperation activities, namely Climate Assessments for GIZ projects, Climate Proofing for Development and Climate Strategy Advice.

Aim

The aim of this course is to enhance capacities among development actors and to support institutions in successfully implementing the Guidance and taking action on climate change adaptation. The teachings of this course provide an introduction to the theory and practical starting points of adaptation to the effects of climate change.

Training participants will learn

- what climate change is and how it is interlinked with development cooperation,
- where to find relevant climate information and how to use it,
- how to think through systematic steps aiming at defining concrete adaptation options at national, sector, local and project levels,
- how to define necessary institutional capacities to carry out a change process and
- how to plan and support processes of mainstreaming adaptation to climate change in their institution.[2]

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[1] http://www.oecd.org/document/26/0,3343,en_2649_34361_44096282_1_1_1_1,00.html

[2] In many cases additional support will be needed. For instance, GIZ's Climate Proofing for Development is always facilitated by experienced experts who have taken a special in-depth training.

Audience

Target groups for the course include:

- administration officials and planners in agriculture, water, natural resources, climate change, as well as other relevant sectors, at national, provincial and local levels,
- national and international development cooperation staff (climate experts as well as sector specialists without a climate change background),
- local consultants on adaptation to climate change,
- NGO / civil society representatives.

Design

The course is designed for a maximum of 4-5 days. Due to its module structure, it can be 'tailored' for shorter training events.

The training consists of **ten modules**[3] that can be selected according to the training needs of the target audience. Together they offer a comprehensive and practice-oriented overview.

- **M 1 – Apply a climate lens:**
  Identify the relevance of climate change to a policy, programme, plan or project.
- **M 2 – Interpret climate data:**
  Understand how to interpret and use different standard climate data sources.
- **M 3 – Assess vulnerability:**
  Identify factors contributing to vulnerability in a system.
- **M 4 – Identify adaptation options:**
  Identify a range of adaptation options to adjust or improve planning and management.
- **M 5 – Select adaptation measures:**
  Evaluate and prioritise options using selected criteria.
- **M 6 – Develop an M&E-framework:**
  Develop elements of a monitoring and evaluation framework for adaptation.
- **M 7 – Develop institutional capacity for adaptation:**
  Identify institutional capacities needed to deal with adaptation as a continual change process.
- **M 8 – Local climate stresses, vulnerability, resilience:**
  Identify local information on climate change vulnerability.
- **M 9 – Take action at local level and beyond:**
  Identify action at the local level and how it links to sub-national, national and other actors.
- **M 10 – Integrate adaptation into the project cycle:**
  Identify key steps to integrate adaptation according to the various steps of the project cycle.

The ten modules are complemented by **Action Learning Exercises**, e.g. on adaptation terminology and framing adaptation.

[3] The main approaches to integrating adaptation outlined in the OECD Guidance are applying a *climate lens* and *the four-step approach*. The OECD Guidance explores entry points for integrating adaptation into development cooperation at national, sector, local and project level. *Module 2: Interpret climate data* and *Module 7: Build institutional capacity for adaptation* are additional.

Training Methodology

The course is based on the Harvard Case Method,[4] which conveys teaching messages mainly through **interactive practical work by trainees**. The training deals with the fictitious Federal Republic of Zanadu, a situation closely based on real life conditions and challenges.

All modules follow the same sequence, including the following crucial elements:

1. The **introduction**, given by the trainer, provides the necessary theoretical background and introduces participants to the case work.
2. The **case work** gives participants the opportunity to work through the different aspects linked to climate change adaptation in a systematic manner. Participants assume the roles of 'case work experts' in charge of the specific module's task.
3. The 'case work experts' **present their results** to the plenary. This is the opportunity to share experiences and for mutual learning. Trainers offer alternatives and corrections when necessary.
4. In a final **reflection**, the participants reassume their own real-life position. They reflect on their experiences and link them to their own work in order to make the newly gained knowledge more applicable. Trainers support through guiding questions.

Guidance for effective group work

- For effective and efficient work, a working group should select a facilitator, a time keeper and a presenter.
- Take your time to read through the task description and see if everybody is on board.
- The working groups work independently.
- Trainers can be asked for advice.
- If not explained differently, matrixes should be worked through in grid lines (not rows)
- The main learning objective is to learn about the systematic approach and not to be comprehensive in the task

Box 1: Guidance for effective group work

Training Package

- The **Training Manual** gives the storyline for delivering the training. It explains the case work tasks per module and includes all necessary supporting information for completing the exercises.
- The **Handouts** provide a summary of learning points and references for each module.
- The **Trainer's Handbook** consists of two parts. Part I presents basics on participatory training methodology and the Case Method and gives hands-on guidance on developing a good training course agenda. Part II provides necessary information as well as suggestions on running the modules and Action Learning exercises.
- A library of **PowerPoint Slides** with notes supports the input sessions.

Download free of charge at: www.oecd.org/dac/environment/climatechange

[4] see e.g. http://en.wikipedia.org/wiki/Casebook_method; http://www.aacu.org/peerreview/pr-wi05/pr-wi05realitycheck.cfm

Introduction to Zanadu

The Federal Republic of Zanadu is a sub-tropical developing country. Because of its large variation in elevations, however, it spans a wide range of climates. These range from a sub-tropical zone in the south with highly seasonal rainfall, to snow covered mountains in the north, to a semi-arid plateau in the west (see map p. 10).

Geography

Zanadu covers an area of 300,000 km^2 (a size similar to Philippines, Ecuador or Ivory Coast). Almost all of the country is drained by the River Alph, which rises in the glacier-covered peaks of the Khorus mountains of the neighbouring nation of Khoresia and enters northern Zanadu draining an area of 350,000 km^2 in both countries. Two thirds of the river's flow originates in Khoresia. The middle reach of the Alph bisects a large, fertile alluvial flood plain. Where the river empties into the sea to the south, it has created a large low-lying delta of fertile sediments.

To the west, the land rises to a plateau of about 1,000 metres, which, while having poor soils, receives more limited rainfall than the rest of the country.

Demographics

The current population is 60 million, giving the country a population density of 200 per km^2 (similar to Pakistan, Burundi, Haiti or Jamaica). Nationwide, the population is almost evenly divided between rural (48%) and urban (52%) areas. However, the rural/urban breakdown differs significantly among states. Population by state and location is shown in the table below.

Zanadu Population		
Location	**Number [million]**	**Share [%]**
South State	**40.0**	**67%**
Urban	25	63%
Rural	15	38%
North State	**8.0**	**13%**
Urban	2	25%
Rural	6	75%
West State	**12.0**	**20%**
Urban	4	33%
Rural	8	67%
Total	**60.0**	**100%**

Table 1: Zanadu population

The population growth rate is currently 1.9% per year, but declining slowly. Median estimate of the expected population in 2050 is 105 million, although this depends on a number of factors and is uncertain. Most of the population growth over the coming 40 years is expected to take place in urban areas, driven by continuing rural to urban migration.

Urban areas are home to a growing middle class, as well as growing areas of extreme poverty, especially due to the influx of unskilled and semi-skilled rural immigrants. Ethnic and clan ties are weakening in urban areas, but remain strong in rural villages.

The national literacy rate is around 68% (76% for males and 60% for females). The country has a widespread primary education system with more limited opportunities for secondary education. There are a number of excellent universities and technical schools which supply government bureaucracies and, increasingly, modern industries created by Foreign Direct Investment (FDI) with professional staff. University graduates constitute only about 5% of the population.

Climate

The climate of Zanadu varies from alpine to sub-tropical. Average values of temperature and rainfall for the three representative locations are shown in the table below.

	Maja, Southern Coast			West Plateau			Alph River Plain		
	Low [°C]	**High [°C]**	**Avg monthly precip [mm]**	**Low [°C]**	**High [°C]**	**Avg monthly precip [mm]**	**Low [°C]**	**High [°C]**	**Avg monthly precip [mm]**
Dec-Jan-Feb	14	27	10	9	23	18	16	24	25
Mar-Apr-May	24	35	60	21	35	13	17	25	75
Jun-Jul-Aug	26	33	236	27	36	182	16	22	200
Sep-Oct-Nov	23	32	121	19	32	56	15	23	58
Total annual precip/ Average temp	**22**	**32**	**1,280**	**19**	**31**	**797**	**16**	**23**	**1,055**

Table 2: Zanadu climate data

The observed change in average annual temperature over the past 50 years ranges from +0.7° C in the Alph delta to +1.2° C in the Khorus mountains. The average sea level at the Maja coastal monitoring station has risen about 10 cm over the same period. Average annual rainfall is largely unchanged, but the distribution has changed markedly, with more runoff in winter and early spring and less in the late summer and fall. Snowmelt discharge is important for meeting irrigation demand for water.

The renewable water availability per capita for the country is currently around 1,600 m^3/year. With population growth, this will fall below 1,000 m^3/capita (by 2040), even if water use remains constant. The Food and Agriculture Organisation (FAO) regards water as a severe constraint on development and environmental protection when internal renewable water availability levels are below 1,000 m^3/capita. At levels below 2,000 m^3/capita, water is regarded as a potentially serious constraint and a problem in drought years.

The National Hydrometeorological Service (Hydromet) collects basic weather data at 30 locations across the country. The Ministry of Water (MoW) records daily river discharge values at 12 sites in the Alph basin, as well as monthly sea level elevations. MoW also conducts a simple snow survey each winter to try to predict snow-melt-based late season river discharges for the following year.

In the past, the lower Alph plain has experienced a devastating flood roughly every 10 to 15 years. In recent years, however, flood frequency appears to be increasing and now occurs about every 8 to 10 years.

Analytic capabilities in Hydromet and MoW are limited. Simple statistical analyses are carried out, but modelling and other predictive studies are seldom done, due to a lack of skills and to the limited demand for such information from senior decision-makers.

Governance

Zanadu is a parliamentary democracy, headed by a Prime Minister, with extensive constitutional powers. International observers report that recent elections have been reasonably open and fair. A small environmental lobby has emerged recently, based in the urban middle-class.

Ministries cover all important sectors at both national and state levels. Most important are the prime ministry and ministries of planning, finance, industry, water resources and agriculture. There are environmental ministries at both national and state levels, but these are not well-resourced. In general, the approach to governance can be described as *reactive* rather than *pro-active.*

There is no established system of water rights in the country. Rights are conferred *de facto*, when a government agency or a private developer creates a new piece of infrastructure which withdraws water from a river or from groundwater. This was not a problem when water was relatively abundant. Increasingly, however, this is leading to conflicts among old and new users.

The national development budget totals around €1,500 million annually, with Official Development Assistance (ODA) constituting about €1,000 million of that or about €17 per capita – about the same as Ethiopia, Azerbaijan, Vietnam or El Salvador. In addition, Foreign Direct investment (FDI) contributes an additional €750 million per year, a value which has grown strongly in recent years.

Administratively, Zanadu is divided into three states[5]: North State, West State and South State. The three states have considerable autonomy, as well as limited taxation powers. Although each state's own revenue funds the state recurrent budget, most of the development budget is provided by the national government.

Infrastructure

All major cities are connected by all-weather roads, but rural connector roads are often in poor condition and sometimes impassable during the rainy season. The most important paved road follows the Alph River north from Maja through the agriculturally important Alph River Valley.

All major cities have electricity, though load shedding sometimes limits hours of availability. At the same time, demand for electricity is expanding rapidly. Only about half of the rural villages are currently electrified with the other half depending on firewood for their energy supply. Power generation is about 15% hydro, with the remainder coming from coal (75%) and natural gas (10%). Almost all of the hydropower is generated at a major dam on the Alph River in North State, although there are several smaller facilities on tributaries. The Alph river dam provides irrigation water storage and flood control services in addition to power generation. There are a number of technically attractive options for additional dam development upstream of the existing dam below the border with Khoresia.

The mobile phone industry is burgeoning, with about 20 million mobile phones now in service. Traditional landline service, outside major cities, is undependable.

[5] Comparable to 'region' or 'province' in other countries.

Economy

The Zanadu economy is in transition from being largely rural and agricultural to one where manufacturing and service sectors predominate. Current shares of different sectors to GDP and employment are shown in the table below. Per capita income is currently around €1,800/year. Five-year average annual GDP growth is about 4%.

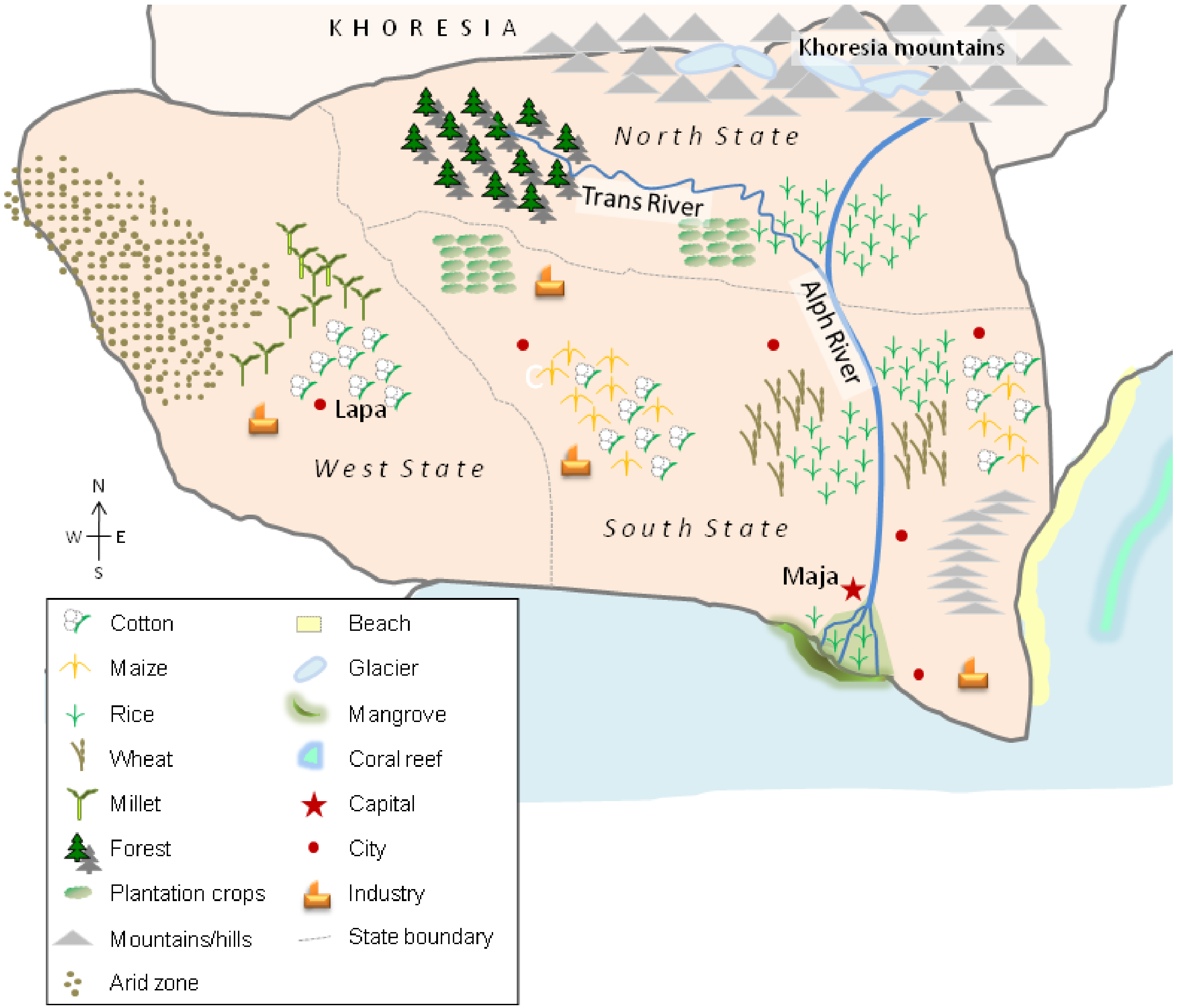
The resource base for the economy includes fertile agricultural land; water resources; coal and some natural gas; hydropower potential; and mountains and sandy beaches with tourism potential, in addition to a sizeable workforce. Agricultural outputs include cotton, sugar, wheat, rice, cacao, palm oil, animal products, timber and some seafood. Rice, cacao, palm oil, timber and seafood are exported. Export-oriented industries constitute roughly 15% of the economy.

Manufactured outputs include textiles (including products from a growing garment industry) simple machinery and fertilizer.

Significant potential for growth exists in the service sector, in areas of tourism, outsourced technical support and software development. Economic opportunities vary significantly between the different states of Zanadu however, and the South State is described in more detail in later chapters.

Shares of GDP and Employment		
Sector	**GDP**	**Employment**
Agriculture	30%	50%
Manufacturing	20%	10%
Services	50%	40%

Table 3: Zanadu GDP and employment per sector



Graph 1: Map of the Federal Republic of Zanadu

Key Features of Zanadu		
Feature	**Value**	**Notes**
Government	Parliamentary democracy	Federal system
Population	60 million	Rural (48%), Urban (52%)
Population growth rate	1.9%	Declining
Literacy rate	68%	Male (76%), Female (60%)
Major river	Alph	Snowfed
Renewable water availability per capita	1600 cubic meters	Declining to 1000 CM by around 2040
Observed temperature rise, 1950-2000	0.7 -1.2 degrees C	Mountains (1.2° C), Delta (0.7° C)
GDP per capita	€ 1800 per year	Varies strongly among regions
GDP growth rate	4% per year	5 year average
Composition of economy	Mixed	Agric. (30%), Mfg. (20%), Services (50%)
Composition of employment	Mixed	Agric. (50%), Mfg. (10%), Services (40%)
Development budget	€ 1500 million	In addition € 750 million from FDI
Power generation	Primarily thermal	Coal (75%), Hydro (15%), gas (10%)

Table 4: Key features of Zanadu

Module 1: Apply a climate lens

Apply a climate lens to a National Development Plan
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective of the exercise

Understand the need to identify the relevance of climate change to a policy, programme, plan or project: Help it become more resilient to climate change or more supportive of adaptation by understanding the relevant climate change risks and opportunities.

Context

The development process of the Federal Republic of Zanadu is steered by the National Development Plan (NDP) 2012-2022. All relevant Sector Ministries are involved in the plan's elaboration under the guidance of the National Planning Commission (NPC) of Zanadu. The next regular revision of the NDP is under preparation.

The Government of Zanadu has decided to reflect climate change adaptation priorities in the new plan. There is a high probability that some current incidences can be linked to climate change: changes to mountain glaciers and snowfall, erosion in coastal areas, declining crop productivity due to drought and less predictable rains. The Government is thus aware that the country's development is being affected by climate change. The overarching development goals of poverty reduction and sustainable economic growth in particular are becoming endangered.

The National Planning Commission has established a climate change advisory group to support this process.

Instructions for case work

- You are members of the climate change advisory group.
- Exhibit 1 provides a first rough outline and the main development goals envisaged for the new plan. The shaded development objectives have been selected for the exercise (see Matrix 1, column A).
- Exhibit 2 gives an overview of climate change and projected impacts for Zanadu.
- Matrix 1 assists in examining these goals through a 'climate lens' in order to identify the relevance of climate change to each goal.

Your task

Your task is to begin to identify the regional priorities and potential administrative responsibilities for further analysis.

- Use Matrix 1 to guide you through the following steps:
- In **column B** for each development goal explain if and how it could be affected by climate change, *e.g. CC could affect the natural resources upon which the goal depends.*
- In **column C**, based on what you know about Zanadu, select the region(s) especially at risk.
- In **column D**, identify the key actors at national level that should take action, *e.g. support further understanding and identifying the risks and responses, take responsibility for the next steps.*

Matrix 1: Assess relevance of climate change to development goals

A Goal	B How could the goal be affected by climate change?	C What region(s) is/ are most at risk?	D What nat. actors should contribute to next steps?
Increase and diversify agricultural production and rural incomes.	• *Ag production and incomes depend on predictable crop yields, which are affected by rainfall patterns* • *Temperature increase impacts on yield (differing by crop)* • *…*	• *West State* • *Alph River plain towards Eastern border* • *…*	• *Ministry of Agriculture* • *State Water Authority (Irrigation dept)* • *…*
Safe drinking water supply and sanitation to be available for 80% of population by 2020.			
Increase the percentage of hydropower from 15 to 25% by 2020.			
Increase forest and tree cover by 5%.			
Maintain minimum flows of all rivers to meet the needs of agriculture, municipal water supply, transport and industry.			
Total fertility rate to be reduced to 2.1 by 2020.			

Exhibit 1: Structure and goals for the Draft National Development Plan 2012 - 2022

(i) Income and Poverty

- Average GDP growth rate of 9% per year in the NDP period.
- Agricultural GDP growth rate at 4% per year on the average.
- Increase and diversify agricultural production and rural incomes.
- Increase share of GDP by new export-oriented industries to 20% by 2020.
- Generation of 6 million new work opportunities.
- Reduction of unemployment among the educated to less than 5%.
- 20% rise in the real wage rate of unskilled workers.
- Reduction in the head-count ratio of consumption poverty by 10 percentage points.

(ii) Education

- Reduction in the dropout rates of children at the elementary level from 52.2% in 2003–04 to 20% by 2011–12.
- Developing minimum standards of educational attainment in elementary schools to ensure quality education.
- Increasing the literacy rate for those aged 7 and above to 85% by 2011–12.
- Reducing the gender gap in literacy to 10 percentage points by 2011–12.
- Increasing the percentage of each cohort going to higher education from the present 10% to 15% by 2011–12.

(iii) Health

- Infant mortality rate (IMR) to be reduced to 28 and maternal mortality ratio (MMR) to 1 per 1,000 live births by the end of the Eleventh Plan.
- Total Fertility Rate to be reduced to 2.1 by the end of the Eleventh Plan.
- Safe drinking water supply and sanitation to be available for 80% of population by 2020.
- Malnutrition among children aged between 0–3 to be reduced to half its present level by the end of the Eleventh Plan.

(iv) Women and Children

- Sex ratio for age group 0–6 to be raised to 935 by 2011–12 and to 950 by 2016–17.
- Ensuring that at least 33% of the direct and indirect beneficiaries of all government schemes are women and girls.
- Ensuring that all children enjoy a safe childhood without any compulsion to work.

(v) Infrastructure

- To ensure electricity connection to all villages and BPL (Below Poverty Line) households by 2020.
- Increase the percentage of hydropower from 15 to 25% by 2020.
- To ensure all-weather road connection to all habitations with populations of 1,000 and above.
- To connect every village by telephone and provide broadband connectivity to all villages by 2020.

- To provide homestead sites to all by 2015 and step-up the pace of house construction for rural poor to cover all the poor by 2016–17.

(vi) Water and Environment

- To increase forest and tree cover by 5 percentage points.
- To attain WHO standards of air quality in all major cities by 2015.
- To treat all urban waste water by 2015 to clean river waters.
- To maintain minimum flows of all rivers to meet the needs of agriculture, municipal water supply, transport and industry.
- To increase energy efficiency by 20% by 2016–17.
- To reduce groundwater withdrawals by 2015.

Exhibit 2: Climate change information and projected impacts for Zanadu

Climate information

Temperature

1. Rising by 2 to 4 degrees C in the Khorus Mountains by the 2050s.
2. On the plains, expected rises of between 1.4 and 2.0 degrees C by the 2050s (compared with 1940-60 average).

Precipitation

1. On average only a slight increase in annual precipitation by the 2050s compared with the 1970 to 2000 average.
2. More autumn and late winter precipitation in mountains to fall as rain rather than snow.
3. Higher intensity rainfall events with longer periods between events.
4. Later arrival, shorter duration of seasonal heavy rains

Sea Level

1. Rise in sea level of 0.2 to 0.4 metres expected by the 2050s.
2. Warmer sea surface temperatures.

Projected impacts

Surface hydrology

1. Snowmelt runoff begins 2 to 4 weeks earlier by the 2050s.
2. More variable river flows.
3. More frequent floods during summer.
4. Longer periods without significant precipitation.
5. Lower late summer river flows.
6. Higher reservoir evaporation losses.
7. Increased erosion of sloping land and reservoir catchments.
8. Larger sediment loads in lower Alph.

<u>Groundwater hydrology</u>

1 Recharge to shallow groundwater reduced by 15 to 25% by the 2050s.

<u>Coastal areas</u>

1 Submergence of about 10% of the Alph river delta by the 2050s.
2 Increased incidence of tidal inundation and storm surges in Delta.
3 Shallow coastal aquifers become more saline.
4 Saline tidal bores push further up the Alph.
5 Less frequent but more intense cyclone impacts.

<u>Agriculture</u>

1 Cotton yields not affected by 1-2°C temperature rise.
2 Maize and wheat yields depressed by 1-2°C temperature rise.
3 Rice threatened with sterility by higher temperatures during flowering.
4 Plantation crop yields enhanced by warmer temperatures (assuming water availability).
5 Crop water requirements increase by 3-5% by 2050.
6 More frequent crop failures due to floods and droughts.

Module 2: Interpret climate data

Apply a climate lens to National Development Plan
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for the exercise

Understand how to use and interpret a standard set of different climate data sources and consider how to integrate it into development planning.

Context

The members of the climate change advisory group, when applying the climate lens to the NDP (Module 1), identified ‘increased and diversified agricultural production and rural incomes’ and ‘safe drinking water supply and sanitation’ as areas of particular concern.

They stated the need for much more detailed information to decide on the extent of impacts.

Instructions for case work

During this step you will further examine the data basis for the review of the NDP.

- You are members of a climate change advisory group established by the NPC.
- On the search for more detailed information and data on climate change in Zanadu you identified the following sources:
  - Exhibit 3: Historic data for one station (capital city Maja) in Zanadu
  - Exhibit 4: Model projections for Zanadu on temperatures for the 2060s
  - Exhibit 5: Scatter plot projections for the sub-continent within which Zanadu is located by IPCC
- Matrix 2 assists the analysis and comparison of different data sources.

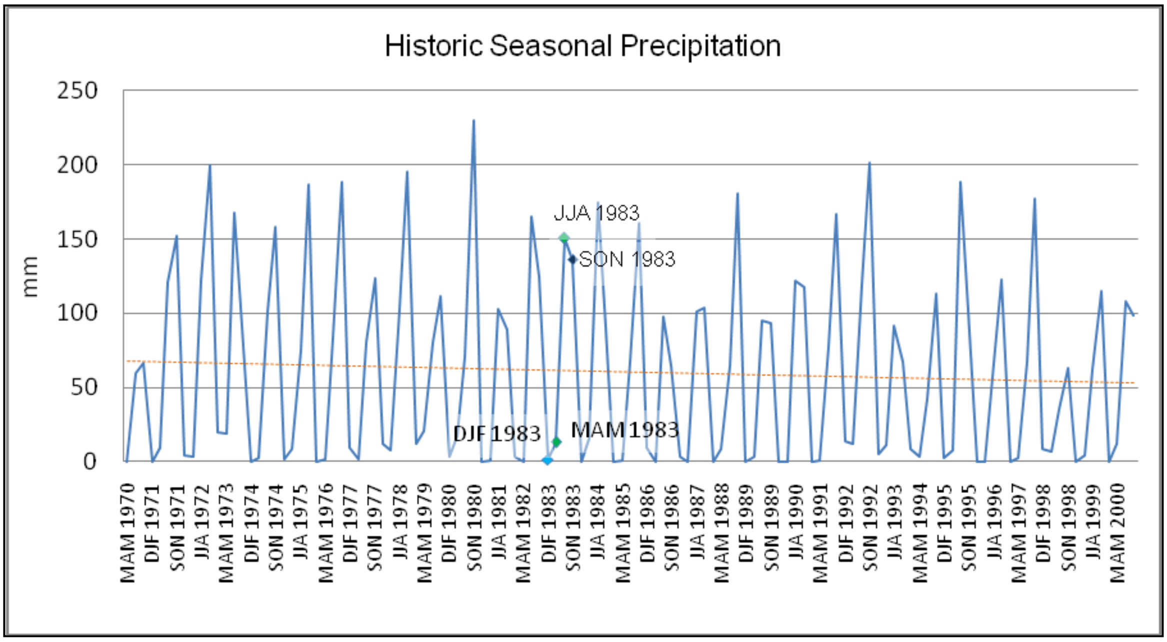
Your task

- Use Matrix 2 to guide your work.
- In **column B** explore what the different data tell you with respect to temperature and precipitation.
- In **column C** discuss what the individual data sets cannot tell you.
- In **column D** brainstorm what additional information you would need for sound decision-making in the two areas of particular concern. Think about key variables needed, appropriate resolution and time scale.

Matrix 2: Analyse climate data

A Source of data	B What does the data tell you about rainfall and temperature?	C What doesn't the data tell you?	D What other data do you need to develop adaptation strategies?
Exhibit 3: Historic rainfall data			
Exhibit 4: Projected temperature map			
Exhibit 5: Model scatter plots for the sub-continent			

Exhibit 3: Historic data from the meteorological station Maja



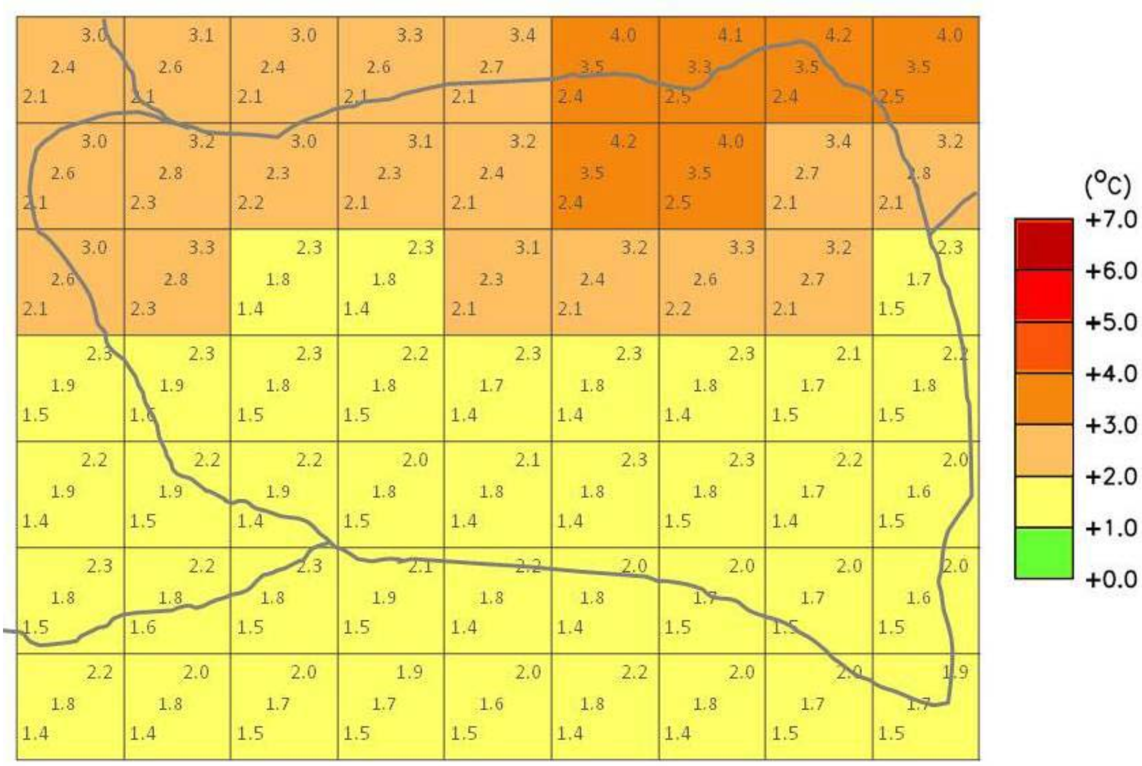
Interpreting this data

Historic precipitation data shows the amount of precipitation (mm) for each seasonal 3-month period (March-May, June-August, September-November, and December-February) based on observations at a meteorological station outside of Maja from 1970 (left)-2000 (right). The peaks can be attributed to the highly seasonal rainfall in summer, which occur in Zanadu during the months of June to September. The minimums indicate the dry cool winter season from December to February.

► *Additional information*

Aside from directly acquiring data from meteorological services, historic data from weather stations for many countries in Africa and Asia (as well as downscaled projections) can be accessed by downloading the Climate Change Explorer Tool:
http://wikiadapt.org/index.php?title=The_Climate_Change_Explorer_Tool

Exhibit 4: Model projections for Zanadu



Interpreting this data

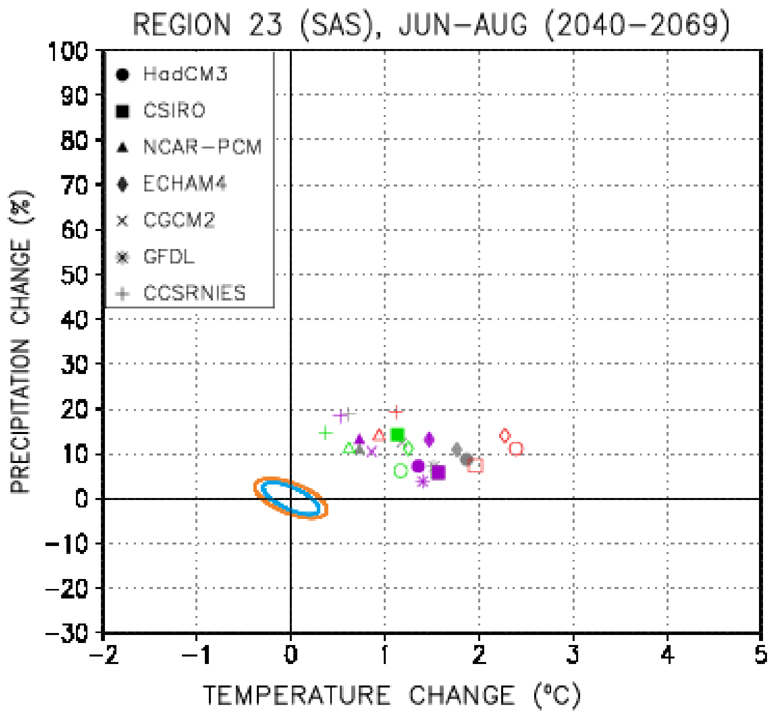
The map shows the spatial pattern of change in mean annual temperature for the 2060s as projected by different available climate models. It is based on the A2 scenario by IPCC. The values in the grid boxes are anomalies (changes in temperature) relative to the mean climate of 1970-1999. In each grid box, the central value gives the median and the values in the upper and lower corners give the maximum and minimum of the range of projections by climate models.

► *Additional information*

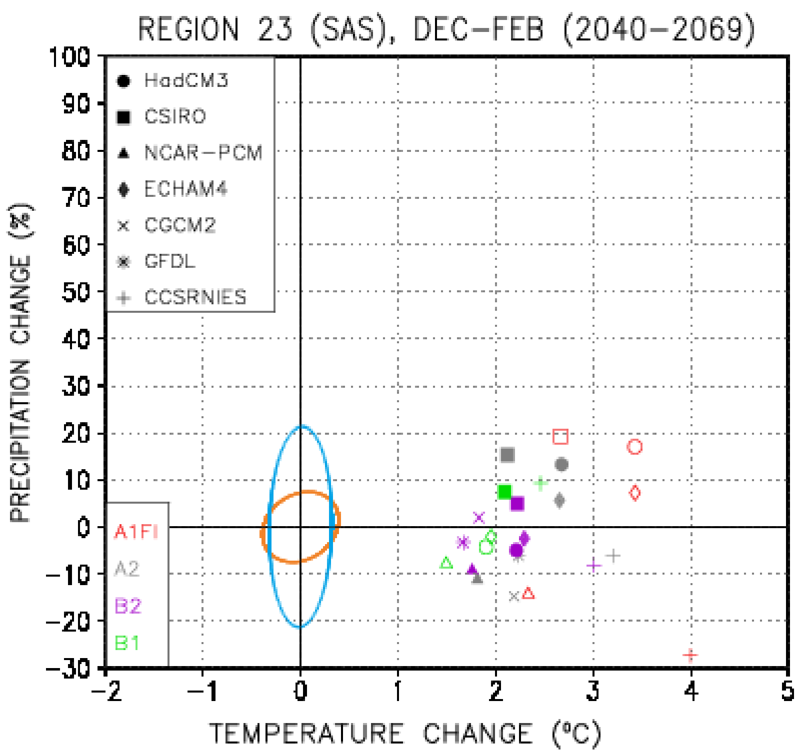
Model projections can be found at http://country-profiles.geog.ox.ac.uk/index.html

Exhibit 5: Scatter plot projections for the sub-continental region of Zanadu

(A) Average projected data for 2040-2069 in June, July and August. Temperature is projected on the x axis and precipitation percentage change along the y axis.



(B) Average projected data for 2040-2069 in December, January and February. Temperature is projected on the x axis and precipitation percentage change along the y axis.



Interpreting this data

IPCC provides long-term assessments for temperature and precipitation as projected through different climate models.

- The ellipses centred on the origin indicate natural variability of temperature (orange) and precipitation (blue) based on historic CGCM2 and HadCM3 model outputs.
- Each point indicates the temperature (along the x axis in °C) and precipitation (along the y axis as a % change from the historic average) projected by a specific scenario and model combination (averaged over 2040-2069).
- The data of seven different global climate models are represented with different symbols (see legend at the top left in scatter plot B).
- The colours represent the four underlying emission scenarios (see legend, bottom, left in the scatter plot B):
  - **A1F1:** results in the highest greenhouse gas (GHG) emissions among the four scenarios.
  - A2: results in the second-highest greenhouse gas emissions among the four scenarios.
  - **B2:** results in the second-lowest overall GHG emissions among the four scenarios.
  - **B1:** results in the lowest overall emissions among the four scenarios.

► *Additional information*

See section 3.1 of the full report for more information on scatter plots http://www.ipcc-data.org/sres/scatter_plots/scatter_plot_report.pdf.

Introduction to South State

South State[6] is the largest, richest and most populous of the three states of Zanadu

Area: 140,000 km^2

Cultivated area: 50,000 km^2 (5 million ha)

Irrigated area: 20,000 km^2 (2 million ha)

Population: 40 million

Population density: 321 per km^2

Geography

The central part of the state is a large fertile alluvial plain, bisected by the River Alph. The Alph has created a large delta of fertile sediments where it empties into the sea. Much of the delta lies just a few metres above sea level. Most of it is protected on the sea side by mangroves.

To the east of the floodplain lies a range of low coastal hills and on the other side of them, a narrow coastal plain that features extensive swaths of white sandy beaches along the seashore. A fringing coral reef lies just offshore. This area has major tourism potential, though facilities are largely undeveloped.

To the west, the land rises toward a plateau which forms most of West State.

Demographics

South state's population of 40 million is two-thirds urban. In addition to the national capital, Maja, which has a population of 10 million, there are five other large cities in the state with a total population of 15 million. Three of these are located along the Alph and two are inland. The rural population of 15 million resides in some 10,000 villages and small towns scattered across the state. Almost all of the population growth is concentrated in the urban areas and comprises a combination of in-migration from rural areas and natural growth.

South State Population [million]		
Location	**Number**	**Share**
Urban	**25.0**	**63%**
Maja	10.0	25%
Medium cities (5)	15.0	38%
Rural	**15.0**	**38%**
Villages (10,000)	15.0	38%
Total	**40.0**	**100%**

Table 5: South State Population

[6] In Zanadu a 'State' is a sub-national entity, in other countries this is also called a 'Province' or a sub-national 'Region'.

Economy

The state is the richest in the country, but also has the largest pockets of poverty. Agriculture contributes 20% to the state's GDP and provides the employment base for 40% of the state's workforce (direct and indirect). The small but growing high-tech sector has considerable potential. There is a growing demand for electricity, which is currently inadequate.

There is an extensive textile industry based on the state's cotton. Cocoa processing has existed since the colonial era and a palm oil industry for both culinary and biofuel uses is undergoing rapid expansion, driven by foreign investment, as a result of rising prices and biofuel mandates and subsidies in Western countries.

Agriculture

The Alph River plain is the breadbasket of the state and the country and supports an extensive rice/wheat crop rotation. Rice is grown during the highly seasonal rainfall in summer, followed by wheat in the dry cool winter season. Almost all of this area is irrigated from large government diversion structures and canal systems on the River Alph. Irrigation for the summer rice crop is supplemental to rainfall. The winter wheat requires irrigation to produce a viable crop.

Further away from the river lies a pair of productive rain fed cotton belts, one on either side of the lower flood plain. Maize is also grown in the cotton belt, interspersed with the cotton fields. Some of these fields are irrigated from private wells.

In the Alph Delta an extensive area is sown to rice in both seasons, though localised flooding from the heavy seasonal rainfall in summer can prevent rice growing in some areas during the summer. Much of the rice is irrigated from simple canals drawing water from the many natural distributaries of the Alph branching through the delta.

Plantation crops are grown in the low hills in the north of the state. Native forest is currently being cleared to allow for expanded production of palm oil. Some growers of both cocoa and oil palm, usually the larger ones, are experimenting with drip irrigation from private wells.

Farm sizes on the Alph River plain are generally small – in the order of three to five hectares. In the Alph River Delta, farm sizes are very small – on the order of 1 or 2 hectares. In the maize and cotton belt, farms are larger – typically on the order of 10 to 20 hectares, but some of the cotton farms are considerably larger. The plantation crops are generally produced on large family or corporate farms. Cropped and irrigated areas are shown below.

Crop	**Area [1'000 Ha]**	
	Cropped	**Irrigated**
Rice/wheat rotation	1,400	1,400
Cotton	2,000	0
Maize	300	50
Plantation crops (cocoa, palm oil)	750	150
Delta rice	500	400
Other crops	50	0
Total	**5,000**	**2,000**

Table 6: Agriculture in South State

Water Supply and Sanitation

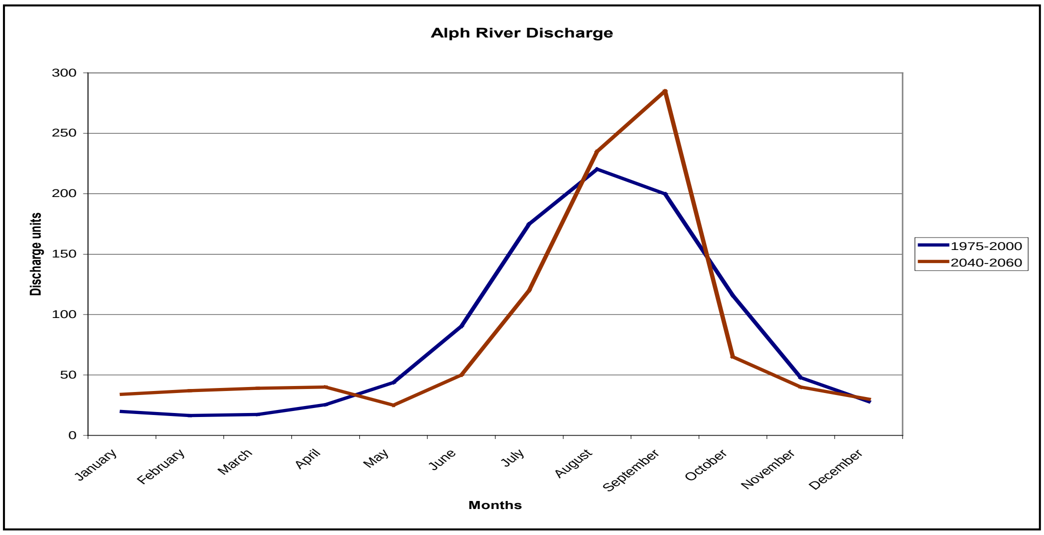
The capital city of Maja distributes treated surface water from the Alph to serve 70% of the city's population. In the five medium cities supply is from pumped groundwater. In the rural areas drinking water is drawn entirely from groundwater. Often this comprises one or several dug communal wells.

About 20% of the wastewater is treated and returned to the river. The remainder of the wastewater flow is piped to an offshore outfall. All five of the medium cities use groundwater as a domestic and industrial water source and, overall, provide piped water to about 50% of their population. All cities have a basic sewerage collection system, but wastewater is discharged into the Alph or a tributary after only primary treatment. Discharge water is typically high in coliform bacteria and sometimes industrial pollutants. In the rural areas there is no wastewater collection or treatment. Wastewater infiltrates into the ground or flows in natural drainage ways to tributaries of the Alph.

Hydrology

Alph River discharge is highly variable across the seasons, with peak flows in July and August at the height of the highly variable summer rains. There is also great variability from year to year. Snowmelt provides much of the flow during the spring before the arrival of the summer rains. Available water during the low flow period following the summer rains is almost completely utilised for irrigation, municipal supply and to maintain navigation access in the country's major port near Maja. Hydrographs for the periods 1975 to 2000 and for 2040 to 2060 are shown below.

Groundwater tables near the river are fairly stable. Further away from the river, levels are dropping at a rate of around 1 to 2 metres per year. In the upland and hilly areas, groundwater is unevenly distributed – present in some places and absent in others. Levels have begun to drop in recent years as more farmers develop groundwater for irrigating maize and plantation crops.



Graph 2: Historical and projected Alph River hydrographs

Climate challenges

Existing climate stresses	Anticipated climate stresses (2020)
Variable rainfall Highly seasonal rainfall Temperature stress on crops	Increasing temperatures 1-1.5°C Declining groundwater recharge Increasing crop water demand Alph peak flow shifts to slightly later in year

Table 7: Climate signals South State

The desired economic growth (increase in agriculture, development of tourism potential, etc.) and population growth place a growing demand on water and electricity supply. Some additional indirect or mutually reinforcing climate change impacts on key development features are presented in the following.

Power supply

Hydropower does have development potential, but that potential may be threatened or rendered very costly by increased sedimentation of the river system.

Water supply and sanitation

Increased water supply from groundwater may amplify the already existing problem of sea water intrusion in coastal aquifers.
Should water supply become costly, this will have immediate effects on the rural and urban poor.

Cities operate sewerage systems, whose capacities might not suffice in situations of higher rainfall and high velocity water flows. These might be at risk considering the projected submergence of about 10% of the river delta.

Agriculture

The Alph River discharge units are projected to change considerably (Graph 2). This will affect the existing irrigation structures (dams, channels, etc.). The functionality of these structures may also be jeopardised by the projected increase in water velocity during rain events and the resulting higher siltation load.

Agriculture in the riverbed, making use of residual soil moisture and/or rain-fed agriculture schemes will be especially affected by changing discharge schemes and unreliable precipitation patterns. Such systems are especially important for poorer farmers who cannot afford irrigated cultivation.

The nexus of 'clearing native forests for plantation followed by increased erosion and sedimentation' will have a deteriorative effect on the groundwater recharge. This is likely to be due to increased run-off and is therefore additional to the projected reduced recharge of shallow groundwater. As a result a race to the bottom may start, leaving the majority of small farms without enough water since they are unable to increase the depth of their water wells.

The South State, and mainly the agricultural sector, is highly dependent on transnational waters, especially during the summer when the Alph River is mainly fed by glacial water from Khoresia.

Module 3: Assess vulnerability

Apply a climate lens to National Development Plan
Interpret climate data
Four-step approach: (1) Assess vulnerability, part 1 and 2
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for the exercise

Learn the first step of the systematic approach to climate change adaptation: identify factors contributing to vulnerability in a system (sensitivity and exposure to climate signals resulting in potential impacts as well as adaptive capacity) and prioritise where action is needed. This step establishes the basis for integrating adaptation into development efforts.

Context

The National Water Policy of Zanadu has been recently updated with goals and priority programmes for 2012-2022. The Ministry of Water (MoW) in cooperation with the Ministry of Agriculture (MoA) has requested each state to review and update their State Water Programmes in line with the new National Water Policy.

Development cooperation partners have pledged financial support for the integration of climate change adaptation into the State Water Programmes. Funding will be allocated for the design and implementation of priority activities to improve sustainable water management under climate change.

In South State, the revision of the State Water Programme will be conducted by the State Water Authority (SWA). SWA's mandate is to sustainably manage surface and groundwater for multiple uses. These include agriculture, drinking water supply and sanitation, flood control, navigation and recreation.

Instructions for case work

General information for Modules 3-6

- You were appointed as a member of an advisory group to the SWA to support the integration of climate change adaptation in the revision of the South State Water Programme.
- The SWA has decided to focus the revision on two key areas:
    - **Increased and diversified agricultural production and rural incomes**
      In order to contribute to this NDP goal, the revision of the State Water Programme aims at maintaining a balance between future water supply and demand for the three important agricultural systems: (a) the rice/wheat rotation in the central plain, (b) upland plantation agriculture and (c) the delta rice growing.
    - **Safe drinking water supply and sanitation:**
      In order to contribute to this NDP goal, the revision of the State Water Programme aims at ensuring safe drinking water supply and sanitation for 80% of population by 2020 for all three systems (capital city of Maja, 5 medium cities, rural areas).

Specific information for Module 3

- Module 3 is step (1) of the four-step approach and deals with assessing the above mentioned systems of interest of the State Water Programme in order to identify relevant needs for adaptation.
- The task is divided in 2 parts.
    - **Part 1** is a preparation step for the comprehensive assessment in part 2. It deals with the recent situation in the system of interest: stocktaking of actors and assets in your system of interest and an analysis of their recent sensitivity and adaptive capacity. (See task description p. 29, Matrix 3 and Matrix 4).
    - **Part 2** deals with the future under climate change. You analyse potential impacts of climate change on your system of interest and finally define the vulnerability / need for action. (See task description p. 31, Matrix 5 and Matrix 6).

Assess vulnerability part 1

In part 1 you gather information to understand the recent situation of the systems of interest. This will help you to do a comprehensive assessment of the vulnerability/the need for action in part 2.

Your tasks

- Use Matrix 3 and Matrix 4 to guide your work.
- First, brainstorm the natural and social assets (*e.g. crops, equipment, community institutions*) and relevant actors (*e.g. farmers, labourers, traders*) within the system.
- In **column A**, list climatic changes already experienced, such as changing precipitation patterns (*e.g. late onset of the rainy season*), temperature extremes, etc.
- In **column B**, consider if and how the system of interest's actors and assets are currently sensitive to climate variability. Think of ecological and social sensitivity. *Examples of sensitivity factors are local housing materials, crop water requirements, resource dependency of a community.*
- In **column C**, elaborate the system's current adaptive capacity, *e.g. a clearly negotiated value chain leaving farmers enough share or access to reliable seasonal weather forecasts would increase the adaptive capacity of a community.*

Matrix 3: Assess sensitivity and adaptive capacity (1)

	A	B	C
System of interest	**Current climate variability**	**Current sensitivity**	**Current adaptive capacity**
Rice/wheat rotation in central plain *(Development objective: to expand production)* Assets • *irrigation technology in place* • ... Actors • *farmers* • ...	• *Extended draught period* • *Heavy rainfall in short periods of time* • *Increasing number of hot days per year* • ...	• *Limited water resources (seasonal precipitation, almost the whole area is already under irrigation)* • *Rice varieties commonly used are sensitive to even small temperature changes* • *Dependency of rural communities on employment in agriculture* • ...	• *Growing service sector in the State offers other employment opportunities (alternative income)* • *Ability of farmers to access forecasts and adjust cropping calendar accordingly* • ...
Upland plantation agriculture *(Development objective: to raise productivity and create jobs)* Assets Actors			
Delta rice growing *(Development objective: to protect existing livelihoods)* Assets Actors			

NB: The revision of the State Water Programme aims at maintaining a balance between future water supply and demand. This has to take into account the development objectives. The development objectives refer to the development goal 'Increased and diversified agricultural production and rural incomes' as given in the NDP (p. 14)

Matrix 4: Assess sensitivity and adaptive capacity (2)

	A	B	C
System of interest	**Current climate variability**	**Current sensitivity**	**Current adaptive capacity**
Urban water supply system (in capital Maja) *(Development objective: to expand coverage)* Assets Actors			
Urban water supply system (in 5 Medium cities) *(Development objective: to expand coverage)* Assets Actors			
Rural water supply systems *(Development objective: to provide coverage)* Assets Actors			

NB: The revision of the State Water Programme aims at maintaining a balance between future water supply and demand. This has to take into account the development objectives. The development objectives refer to the development goal 'Safe drinking water supply and sanitation to be available for 80% of population by 2020' as given in the NDP (p. 14).

► *Additional information*

The following steps in part 2 are an adapted and simplified version of the assessment in ***GIZ's Climate Proofing for Development*** *(CP4Dev). CP4Dev has been developed by GIZ as a comprehensive tailor-made support package for institutions in developing countries. It includes process facilitation for integrating climate change aspects into development planning, participatory development of a tailor-made methodology and material, extensive capacity building and support for follow-up, learning and quality control of adaptation. It has been used successfully in more than 10 countries on national, sectoral and local level as well as in projects. For further information please contact climate@giz.de.*

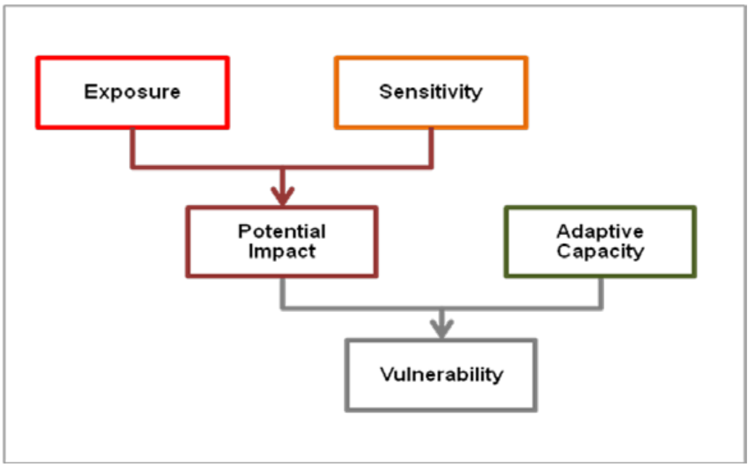
Other ***Screening Tools and Instruments for Mainstreaming Adaptation*** *can be found in UNDP's stocktaking report at http://www.undp.org/climatechange/library.shtml.*

Assess vulnerability part 2

Part 2 works through potential impacts on the biophysical and socio-economic components of the system. Information from part 1 (sensitivities and adaptive capacities) supports this assessment.

Your tasks

- Review Graph 3 below (and glossary) to ensure that you have in mind the different terms and their connection.
- Use Matrix 5 and Matrix 6 to guide your work.
- In **column D**, identify the key climate change signals of concern. Review information provided about South State and in Exhibit 2. (If you did M2 use what you have learned.).
- In **column E**, brainstorm the potential impacts to the biophysical part of the system by considering column D in combination with the sensitivity factors (part 1 column B), *e.g. dry spells lead to lack of groundwater recharge.*
- In **column F**, brainstorm socio-economic impacts that you expect to result from climate change (column D) and the biophysical impacts (column E). Also take into account sensitivity factors (part 1, column B). You may also want to consider positve impacts. *E.g. reduced production and loss of income as there is not enough water for irrigation.*
- In **column G** rate vulnerability on a scale from 1-5. This gives an indication of the need for action.
    - Recall that vulnerability is a function of exposure, sensitivity, and adaptive capacity; and that oftentimes, development action addresses vulnerabilities.
    - Discuss columns E and F using the following questions:
        - How relevant are the potential impacts to the development objective?
        - How likely is the impacts' occurrence?
        - What is the extent of expected damage?
    - Take into account adaptive capacity (part 1, column C). If the system can deal with impacts without external support, it is considered less vulnerable.
    - Summarise your findings by indicating 1-5 for the extent of vulnerability (5 = highly vulnerable).
    - Add a short explanation (for documentation).



Graph 3: Vulnerability functions

Matrix 5: Assess impacts, vulnerability and define need for action (1)

	D	E	F	G
System of interest	**Climate change signals of concern the system of interest is exposed to**	**Potential biophysical impacts** (also considering sensitivity [B])	**Potential socio-economic impacts** (also considering sensitivity [B])	**Rate vulnerability and need for action 1-5** (also taking into account adaptive capacity [C])
Rice/wheat rotation in central plain *(Development objective: to expand production)*	• *Seasonal rain pattern becomes erratic* • *Dry spells*	• *Rice sterility with temperature increase*	• *Decreasing rice yields* • *Loss of income* • *Adverse effects on food security*	4: very vulnerable, high damage if less production possible: food security issue and loss of GDP
Upland plantation agriculture *(Development objective: to raise productivity and create jobs)*				
Delta rice growing *(Development objective: to protect existing livelihoods)*				

NB: The revision of the State Water Programme aims at maintaining a balance between future water supply and demand. This has to take into account the development objectives. The development objectives refer to the development goal '"Increased and diversified agricultural production and rural incomes' as given in the NDP (p. 14).

Matrix 6: Assess impacts, vulnerability and define need for action (2)

	D	E	F	G
System of interest	**Climate change signals of concern the system of concern is exposed to**	**Potential biophysical impacts** (also considering sensitivity [B])	**Potential socio-economic impacts** (also considering sensitivity [B])	**Rate vulnerability and need for action 1-5** (also taking into account adaptive capacity [C])
Urban water supply system (in capital Maja) *(Development objective: to expand coverage)*				
Urban water supply system (in 5 Medium cities) *(Development objective: to expand coverage)*				
Rural water supply systems *(Development objective: to provide coverage)*				

NB: The revision of the State Water Programme aims at maintaining a balance between future water supply and demand. This has to take into account the development objectives. The development objectives refer to the development goal 'Safe drinking water supply and sanitation to be available for 80% of population by 2020' as given in the NDP (p. 14).

Module 4: Identify adaptation options

Apply a climate lens to National Development Plan
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for the exercise

In the systematic approach to climate change adaptation, learn as a second step how to identify a range of options to adjust or improve water management under a changing climate.

Context

Climate change adaptation is a new challenge for the SWA. Some existing activities may be helpful. However, new responses have to be found to ensure sustainable water management.

Instructions for case work

- Module 4 is step (2) of the four-step approach.
- Your task as an advisory group, after having identified the need for action, is to ask: "what could be done to respond to the challenges?"
- At this point it is important to think as broadly as possible to come up with new ideas. The exercise is therefore conducted via brainstorming. (This means that for the time being all ideas that you can come up with are welcome. No idea should be criticised; limiting factors will be reflected during the analysis in the next step.)
- Exhibit 6 provides you with a checklist of adaptation options in agricultural and water supply issues.
- Matrix 7 and Matrix 8 help organise your work. These include already selected climate impacts leading to high/medium vulnerability in column H.

Your task

- Review the selected climate change impacts **in column H** and, if you want, add from your work in M3.
- Recall that you are an advisory group to the SWA and that you are asked to support the integration of climate change adaptation in the revision of the South State Water Programme.
- In **column I** devise adaptation options that can reduce vulnerability with respect to selected impacts leading to high/medium vulnerability in column H.
    - Check Exhibit 6 and select adaptation options that you find helpful.
    - Add by thinking through all categories of adaptation options (see glossary). Recall that adaptation options could
        - prevent, reduce or avoid the damaging biophysical and socio-economic impacts.
        - enhance opportunities from climate change.
        - enhance the adaptive capacity of relevant actors.
- In **column J** reflect on main actors that will be crucial to implement the devised options.

Matrix 7: Develop adaptation options (1)

System of interest	H Selected impacts leading to high/medium vulnerability and need for action	I Adaptation options	J Relevant actors / stakeholders
Rice/wheat rotation in central plain *(Development objective: to expand production)*	• Rice sterility (due to higher temperatures) • Lower yields (water availability does not meet crop water requirements due to higher evapo-transpiration and increasingly erratic seasonal rainfall patterns)	• *Develop water retention facilities for groundwater recharge (strong rains cater for dry spells)* • *Raise water prices and inform about water-saving irrigation techniques* • *...*	• *SWA irrigation dept* • *Agricultural extension services* • *Farmers' Association* • *...*
Upland plantation agriculture *(Development objective: to raise productivity and create jobs)*	• Higher crop yields with temperature increase, limited by higher evapo-transpiration • Drought damage (due to dry spells) • Declining groundwater tables (due to shifting rainfall and over-pumping) • Soil erosion (due to intense rainfall and human pressures)		
Delta rice growing *(Development objective: to protect existing livelihoods)*	• Inundation of fields and settlements (due to sea level rise, intense rain and storm events) • Damage to land and settlements (due to increasing storm surge) • Damage to settlements (due to higher cyclone winds)		

NB: The revision of the State Water Programme aims at maintaining a balance between future water supply and demand. This has to take into account the development objectives. The development objectives refer to the development goal 'Increased and diversified agricultural production and rural incomes' as given in the NDP (p. 14).

Matrix 8: Develop adaptation options (2)

System of interest	H Selected impacts leading to high/medium vulnerability and need for action	I Adaptation options	J Relevant actors / stakeholders
Capital city water system *(Development objective: to expand coverage)*	• Ongoing salinisation of groundwater (due to salt water intrusion from coastal aquifer) • Inadequate river water supplies at low flow (due to temperature and precipitation changes) • Infrastructure damages (due to increase in sediment load in Alph river flows by intense rainfall)		
Five medium city water systems *(Development objective: to expand coverage)*	• Falling groundwater levels (due to lower recharge and over-pumping) • Declining groundwater quality (due to lower recharge and pesticides)		
Village water systems *(Development objective: to provide coverage)*	• Falling groundwater levels (due to lower recharge and over-pumping) • Incidents of water shortage have dramatic consequences for human health (due to lack of alternative water sources)		

NB: The revision of the State Water Programme aims at maintaining a balance between future water supply and demand. This has to take into account the development objectives. The development objectives refer to the development goal ‘Safe drinking water supply and sanitation to be available for 80% of population by 2020’ as given in the NDP (p. 14).

Exhibit 6: Checklist of adaptation options (agricultural and municipal water supply, use and management)

Types of options: Infrastructure = I, Policy = P, Capacity = C, Good Practices = GP

Supply-based options

1. Install more wells (I)
2. Construct more diversion structures on river (I)
3. Construct on-stream storage dams (I)
4. Artificially recharge groundwater (I, GP)
5. Treat and reuse wastewater (I)
6. Desalinate brackish or saline water (I)
7. Re-allocate water among sectors or users (P)

Demand-based options

1. Shift to higher-value lower-water consuming crops (GP)
2. Promote drip irrigation technology (I, GP)
3. Line irrigation canals (I)
4. Develop and promote revised agricultural practices and crop choices (P)
5. Improve management of abstracted water (information systems, management practices, human resource capacity building) (GP, C)
6. Promote water conservation in urban areas, greywater use and sanitation (GP, P)
7. Physically ration water (P, GP)
8. Introduce water pricing/raise water rates (P)
9. Upgrade water infrastructure (I)
10. Reduce unaccounted for water (GP)
11. Introduce incentives (and disincentives) for careful water use (overuse) (P)
12. Introduce payment for environmental services (P)
13. Regulate groundwater withdrawals, introduce fees (P)

Information-based options

1. Expand monitoring programmes for water supply and use, climate, agricultural output, water quality and ecosystem health (e.g. installation of meteorological stations) (C)
2. Develop capacity to model climate change effects on a regional scale (C)
3. Develop and apply models to assess potential impacts of climate change parameters on agricultural production and economic returns to agriculture (C)

Other options

1. Develop and distribute new seed varieties (GP)
2. Relocate vulnerable populations (P)
3. Relocate vulnerable infrastructure (P)
4. Set and enforce wastewater discharge standards (P)
5. Enhance watershed management (GP)

Module 5: Select adaptation measures

Apply a climate lens to National Development Plan
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for the exercise

In a systematic approach to climate change adaptation, learn as a third step how to identify appropriate criteria, use them to evaluate alternative adaptation options and come up with a set of deliberately chosen adaptation measures.

Context

As stated at the beginning, development cooperation partners have pledged financial support for the integration of climate change adaptation into Water Programmes for 2012-2022. MoW in co-operation with MoA will prioritise strategic investments for priority activities to improve water management under climate change.

SWA thus asked the advisory team, after having identified a broad set of adaptation options, to suggest a selection of the most relevant measures.

Instruction for case work

- Module 5 is step (3) of the four-step approach. As an advisory group you now engage in a transparent and systematic selection process.
- Following a set of criteria, you choose the most suitable adaptation options from the list compiled in step (2). This selection forms the basis for defining distinct measures and developing an adapted water management strategy for SWA
- Box 2 gives an overview of different possible selection criteria
- Matrix 9 provides a grid to evaluate the different adaptation options

Your task

Use Matrix 9 to guide your work:

- To fill in **column I** transfer the potential adaptation options from Module 4 column I.
- In **columns K, L, M, N, O,**
    - agree on the selection criteria (as given by the Guidance and add other criteria if desired (e.g. see Box 2)).
    - consider each option (I) using the criteria and score them by using ++ / + / 0 / - / --
- In **column P** evaluate the options.
    - If too many options have similar evaluations, you might think of introducing another criterion or weighting the criteria (*e.g. criterion 3 "feasibility" x2*).
- Using a 'bird's eye view' reconsider whether the results make sense.
    - Do they address the key vulnerabilities?
    - Would they be effective together?
    - Do they overlap or complement each other?

Criteria for selecting adaptation measures

The OECD Guidance recommends the following key criteria:

- **Effectiveness**: describes the extent to which the adaptation option reduces vulnerability and provides other benefits. Think of effectiveness of the adaptation option under different scenarios.
- **Costs**: describes relative costs of an adaptation option. Think of investment costs as well as costs over time, such as operation and maintenance costs, reconstruction costs, etc. Think of economic and non-economic costs. Think of costs of avoided damage.
- **Feasibility**: answers whether the necessary legal, administrative, financial, technical, etc. resources exist. Adaptations that can be implemented under the current operational framework will usually be favoured.

Additional criteria may include, depending on the context, e.g. political and social acceptance, urgency, biodiversity friendliness, relative speed of implementation or benefits, 'no regrets' potential, avoid detrimental effects on other development goals, alignment with funding requirements or other eligibility criteria, alignment with policy priorities, etc.

Other relevant questions are "What happens if you don't take a specific action?"; "If the adaptation measure is already being implemented, would it need additional funding to improve or to do more of the same?".

HINT: Rate all criteria the same way: ++ being positive in terms of implementation (e.g. high costs would be --) – Otherwise you will face difficulties in calculating an overall score.

Box 2: Criteria for selecting adaptation measures

Matrix 9: Select adaptation measures based on criteria

IAdaptation options	K Criterion 1 Effectiveness	L Criterion 2 Cost	M Criterion 3 Feasibility	N Criterion 4:	O Crite-rion 5:	Overall evaluation
Raise water prices and in-form on water-saving irrigation techniques	*0 (Needs to be accompanied by other mea-sures to in-crease overall water volume)*	*+ (Price increase compensates costs of info campaign)*	*0 Technology is there, but farmers' union has strong influence on politics*	*If criterion were: no regrets ++*	*N/A*	*0/+*

Module 6: Develop a monitoring and evaluation framework

Apply a climate lens to National Development Plan
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop a monitoring and evaluation framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for this exercise:

In a systematic approach to climate change adaptation, thinking in results chains contributes to effectiveness. You learn how to define elements of the monitoring and evaluation (M&E) framework. Developing an M&E framework as part of the planning also gives you the opportunity to review the last steps and see if the devised strategy is comprehensive.

Context

The adaptation advisory team to the SWA has developed a coherent adapted water management strategy based on both stakeholder and expert inputs. The strategy has been proposed to the SWA for inclusion in the revised State Water Programme. The strategy aims to provide sustainable water resources for the two NDP goals: (1) increased and diversified agricultural production and rural incomes and (2) safe drinking water supply and sanitation. This requires balancing future water supply and demand by taking into account impacts from climate change.

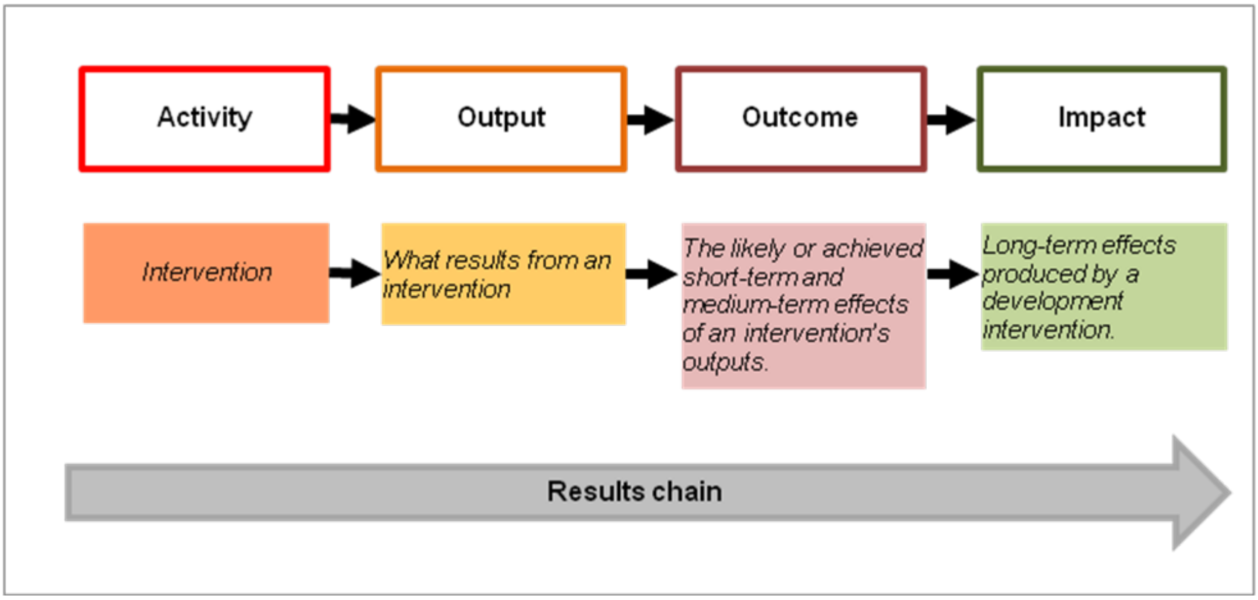
As a last step, SWA now requests support in terms of an M&E framework with a results chain and indicators for major components of the strategy to ensure its effectiveness. The M&E framework will guide SWA in its management, in tracking the delivery of results and in increasing its response capacity by learning from the executed activities.

Instructions for case work

- Module 6 is step (4) of the four-step approach and deals with setting up an M&E framework.
- Matrix 10 and Matrix 11 assist you in thinking through a results chain (Graph 4), developing indicators and discussing sources of data.
- Box 3 and Box 4 give indications on how good indicators should be formulated.

Your tasks

- In Matrix 10 note down the desired long-term impact for SWA's strategy (you may want to check the introduction texts for M3-M6). This helps you to orient the M&E framework.
- Use Matrix 11 to guide your work
  - Column A depicts a set of selected adaptation measures, components of the strategy for SWA's future engagement towards in a climate-resilient water sector.
  - In **column B** think through the outputs and outcomes of the measures. Link them to the overall desired result (impact). Graph 4 explains the logical framework of a results chain.
  - In **column C** brainstorm potential indicators for the results of the activity, outputs and outcomes.
  - In **column D** suggest possible sources of data for tracking each indicator. Select the indicator that you find most suitable.



Graph 4: Results chain[7]

Matrix 10: Define the desired impacts

What are the desired impacts that the adapted water management strategy aims at?
e.g. increased water availability

[7] For more information see OECD (DAC) 2002; "Glossary of Key Terms in Evaluation and Results Based Management"; Evaluation and Aid Effectiveness, No 6 http://www.oecd.org/dataoecd/29/21/2754804.pdf

Criteria for the selection of good indicators

- Validity and accuracy: the indicator precisely reflects the subject under observation
- Precision: the indicator's formulation contains no ambiguity
- Relevance: the indicator reflects a relevant aspect of the overall subject
- Robustness: the indicator is related to global and lasting characteristics of the subject (to avoid too much sensitivity to accidental fluctuations)
- Sensitivity: the generated data vary significantly when a change occurs in what is being observed
- Feasibility: the data necessary to monitor the indicator should be readily available and/or affordable to collect

Box 3: Criteria for the selection of good indicators

Steps towards output indicator formulation

1. Define indicator, *e.g. qualification of water management staff*
2. Specify quantity of change, *e.g. 50% of all water managers trained*
3. Specify quality of change, *e.g. trained in up-to-date water management techniques*
4. Define time horizon, *e.g. within the next two years*
5. If applicable: specify regional aspect, *e.g. water management staff within South State*

Box 4: Steps towards output indicator formulation

Matrix 11: Develop an M&E framework

<table>
<tr><th>A Adaptation measures
selected components of the proposed strategy</th><th>B How does the measure link to the overall aim of SWA's strategy (Matrix 10)?</th><th>C Possible indicators</th><th>D Sources of data, means and schedule for collection</th></tr>
<tr><td rowspan="2">Train water managers on storage practices, maintenance of transmission system, irrigation practices and contingency planning</td><td>B1 Output:
• Qualified water management staff</td><td>C1 Output:
• 50% of water managers trained in up-to-date water mgmt techniques within the next 2 years
• …</td><td rowspan="2">• SWA internal M&E (quantitative survey, every year)
• ...</td></tr>
<tr><td>B2 Outcome:
• SWA's Water Management operational</td><td>C2 Outcome:
• SWA water management unit fulfil annual plan
• …</td></tr>
<tr><td>Introduce a tiered water pricing system for domestic water service</td><td></td><td></td><td></td></tr>
<tr><td>Expand water storage capacity (retention basins)</td><td></td><td></td><td></td></tr>
<tr><td>Advise on terraces construction in agricultural fields</td><td></td><td></td><td></td></tr>
<tr><td>Introduce drip irrigation technology</td><td></td><td></td><td></td></tr>
<tr><td>Set-up an advisory panel with SWA, MoA, Hydromet, water providers and agriculture industry groups to advise water management with respect to climate change.</td><td></td><td></td><td></td></tr>
</table>

Module 7: Build institutional capacity

Learning objective for the exercise

Understand that action on adaptation requires adequate institutional capacities. Learn how to deal with adaptation as an ongoing institutional change process.

Context

SWA recognises that adaptation requires appropriate management structures, processes and activities. Its members therefore wish to develop capacity within the Authority to deal with water management and adaptation in a systematic and proactive manner.

Instructions for case work

- SWA has chosen to build on the National Adaptation Capacity Framework.[8] It requests your team's support to provide guidance on building capacity in these five functions: Assessment, Planning, Information Management, Coordination, Implementation. Box 5 gives you some explanation on the different functions.
- Matrix 12 assists you in reviewing existing capacities in the Authority in order to define emerging needs for capacity development.

[8] This adapts work undertaken by a World Resources Institute (WRI) project to identify national adaptation functions. See: www.wri.org/project/vulnerability-and-adaptation.

Your task

- Recall the challenges facing sustainable water management in the South State and the mandate of the State Water Programme: sustainably managing surface and groundwater for multiple uses (agriculture, drinking water supply and sanitation, flood control, navigation and recreation).
- Use Matrix 12 to guide your work. Column B lists what the SWA is already doing to carry out key functions for managing water in the state.
- In **column C**, building on this basis, brainstorm recommendations, what short-/medium-term activities are needed to integrate adaptation to climate change in SWA's work.
- In **column D**, brainstorm which capacity development activities are needed in SWA to implement the new activities.
  Think of individual (human resources, *e.g. focal points trained on using scenarios*) and organisational capacities (*e.g. management team plans by using the four-step approach*); you may also find institutional capacities that can be enhanced within the network of concerned institutions (*e.g. exchange with other sector agencies*).
- In **column E**, look into activities to improve the water management in the long-run.

The National Adaptive Capacity Framework asks ***"what can I do that helps me adapt?"***
It is a centered around ***five key institutional functions*** *(cannot be accurately separated):*

- ***Assessment****: Adaptation requires new information on climate change, its impacts as well as successful management interventions, e.g. climate data by region, vulnerability assessments, climate change impact assessments, evaluation of adaptation practices.*
- ***Planning****: Adaptation requires strategic and systematic processes in order to define the right priorities. This demands looking into various time horizons, geographical inter-linkages, specific vulnerabilities, etc. e.g. systematic approach to addressing the projected climate change impacts across society.*
- ***Coordination****: Adaptation is not a one-man-show and cannot be dealt with at one desk. Coordination aims to join forces, to avoid duplication or gaps and create economies of scale in responding to climate change challenges, e.g. horizontal coordination between the Ministries of Water and Agriculture, vertical coordination between National and State level, policy dialogues including civil society representatives.*
- ***Information management****: Adaptation requires adequate information management. Most institutions have management structures, processes and tools to build on; develop these rather than inventing a new system. This is especially important as change often produces resistance, mistrust etc. if not carefully introduced.*
- ***Implementation****: Adaptation also means implementation of climate risk reducing measures, e.g. water retention structures, contingency planning.*

Box 5: The National Adaptive Capacity Framework

Matrix 12: Develop institutional capacity for adaptation

A State water programme functions/ capacities	B Existing activities for water management	C Which short-/ medium-term activities are needed to integrate adaptation in SWA's work?	D What capacity development activities are needed to implement the new activities?	E Which long-term activities could improve water mgmt under CC?
Assessment <u>Concerns</u>: emerging climate risks, adaptation options	• State water resources inventory • Projected water demand and supply scenarios	• *CC scenarios* • *CC impact assessments* • *Identification of adaptation options* • *Vulnerability assessment*	• *Train adaptation focal points on scenarios* • *Train management team on the 4-step approach* • *Organise regular meetings with all concerned departments*	• *Joint impact assessments with water and climate change experts* • *Cross-check projected developments with existing country data* • *Evaluate implemented adaptation options for their performance*
Planning <u>Concerns</u>: strategic adaptation planning	• 10 yr resource mgmt plans • Allocation based on national criteria • Infrastructure design standards			
Coordination <u>Concerns</u>: organisation and leadership for adaptation	• Exchange of data with neighbouring states • Outreach to major users and polluters			
Information management <u>Concerns</u>: integrate up-to-date climate info in programmes	• Policy documents published on the website			
Implementation <u>Concerns</u>: sustainable water mgmt under climate change	• Funding for projects identified in 10 year plans			

Introduction to West State

Geography

The area of West State is 60,000 square kilometres, 20% of the national total. It has a sub-tropical semi-arid climate with extended arid areas in the west. The State receives on average about 400 mm of rainfall annually. Most of the precipitation is concentrated in the four months from June to September, while the rest of the year is quite dry.

Soil quality is rated medium to poor. They are in parts heavily eroded and depleted of nutrients from mismanaged agriculture and livestock grazing.

Demographics

The state's population is currently 12 million, of which two-thirds is rural. It contains one major city, Lapa, the state capital, several towns and numerous small villages. The Talaran District in the northwest has a population of about 50,000. It is mainly arid. The District is experiencing rapid population growth.

Economy

The state's economy is agriculture-based. Overall, its per capita income is just 60% of the national average. There is an extensive area of cotton cultivation around Lapa. This is the wealthiest part of the state. The northwest region in and around Talaran District is one of the poorest regions in the state. Its local economy is based on limited rain-fed cereal production and mainly livestock grazing. Land used for agriculture, forestry and pasture farming is being degraded and parts are no longer suitable for use. As a result poverty and conflicts among sectors of the population are emerging. Transportation links with the rest of the state are poor.

Agriculture

Agricultural yield in West State is extremely sensitive in relation to climatic conditions; therefore it can be assumed that climate change will affect food security.

Farmers and pastoralists observe a rise in temperatures in general all year round, with a tendency that the duration of the dry season extends. In addition there are stronger storms, partially from directions which are atypical for the respective season.

The direct effects of these climatic changes are increased evaporation, a reduced infiltration of rainfall into the soil and groundwater, an increased land surface temperature as well as increased stress on flora and fauna with extensive consequences for the ecological systems and production systems of the rural population.

Due to temperature change and significantly shortened rainy season traditional millet and sorghum varieties are no longer able to reach the stage of ripening, as they need between 120 to 150 days to mature. Small-scale farmers have observed that the rainy season used to start in May; today they can only sow in July. The rain stops as early as the end of September and the millet seeds do not ripen, so millet stocks remain empty.

Many small scale famers try to extend the range of cultivated crops such as beans, pigeon beans or groundnut, in order to reduce the risk and to improve the sustainability of the soil by applying a wider crop rotation. A few villages with access to groundwater started with the growth of seasonal horticulture.

Pastoralists are reporting that their animals can no longer find enough fodder and many nutritious herbs and grasses have disappeared. Instead there are many types of grass, which the animals do not consume. They complain that the water in the valleys dry out too early and they must divide their herds and visit far-removed pastures in different regions during the drought periods.

The trade of grains in West State has changed during the last decades and became more important. Today, self-sufficient rural households are rare and the rural population has to buy a part of their grain for consumption on the market.

Climate change information and projected impacts for West State

Climate information

Temperature

- Expected rise of between 1.5 and 2.5 degrees C by the 2050s (compared with 1940-60 average).

Precipitation

- On average a slight decrease in annual precipitation by the 2050s compared with the 1970 to 2000 average.
- Higher intensity rainfall events with longer periods between events.
- Later arrival, shorter duration of seasonal heavy rains.

Projected Impacts

Surface hydrology

- Longer periods without significant precipitation.
- Increased erosion of sloping land and reservoir catchments.

Groundwater hydrology

- Recharge to shallow groundwater reduced by 15 to 25% by the 2050s.

Agriculture

- Millet and cotton yields depressed by temperature rise.
- Crop water requirements generally increased by 3 to 5% by the 2050.
- More frequent crop failures due to droughts.
- Increasing incidences of overgrazing due to poor pasture quality and reduced rainfall.

Module 8: Local climate stresses, vulnerability and resilience

Learning objective for this exercise

Learn about local information on climate change and vulnerability.

Context

The fragile natural resources of the Talaran District in Zanadu's West State, as well as the people who depend on them, are threatened by rapid population growth combined with inappropriate resource management. Land used for pasture farming, agriculture and forestry is being degraded and parts are no longer suitable for use. Water is becoming a more and more pressing issue. Pressure on remaining resources is constantly increasing. As a result, poverty and conflicts among sectors of the population are emerging.

A number of Sustainable Rural Development projects focused in different sectors are being supported by donor agencies. The District Government decided that the projects should be reviewed in order to integrate adaptation to climate change, since observed and expected climate change is likely to intensify existing stresses.

Instructions for case work

- One project is focused on participatory community development plans.
- You are a group of community members (either pastoralists or farmers) and take part in the project review.
- A first stocktaking workshop with all relevant stakeholders was recently conducted. Exhibit 7 shows the summary report, consisting of a hazard map, list of problems the stakeholders identified and selected stories.
- You are in a follow-up workshop, where you aim to systematise and explore these concerns. Matrix 13 assists in capturing your new insights.

Your task

- Settle firmly in your stakeholder group perspective: farmer or pastoralist.
- From this perspective review the report from the first stocktaking workshop in Exhibit 7 (A), (B) and (C).
- Use Matrix 13 to guide your work.
- In **column A** discuss the key dynamics of climate change in your community:
  - What are the priority climate-related stresses to which you are exposed?
  - In which ways is your group sensitive to climate change?
  - What is your group's coping and adaptive capacity?
- In **column B** identify tools of Participatory Rural Appraisal (PRA); see Annex p. I for suggestions) that could be used to deepen understanding of these key dynamics – climate stresses on livelihoods, sensitivity and adaptive/coping capacity.

Matrix 13: Collect stakeholder perspectives

	A Stakeholder group perspectives (farmers or pastoralists)	**B What PRA tool(s) could you use to explore this issue further? How would you use them?**
Key non-climate stresses on livelihoods		
Key climate-related stresses on livelihoods (exposure)		
What makes your group sensitive to climate change?		
What adaptive and/or coping capacities does your group have?		

Exhibit 7: Report from the first stocktaking workshop

(A) Brainstorm of problems:

- unreliable electricity
- poor road to Talaran capital
- drying wells
- loss of soil during heavy rains
- drying of lakes
- degradation of pasture
- animal deaths during dry spells
- food insecurity when rains are weak and crops fail
- declining fuelwood sources
- pests
- loss of jobs and men going to town for work
- more dengue cases

(B) Hazard Map

(C) Local stories

"In 2005, the rains arrived three weeks later than usual and a number of intense rainfall events occurred once the rains arrived. Millet farmers lost crops due to the late onset of rain. Farmers with sloped land and degraded grazing areas lost soil. Farmers with a variety of crops fared better than those who had planted fewer crops and families that also had livestock were able to sell them for emergency income and supplement their diets."

"Landless labourers are facing increasing problems in our region. During years with poor yields they cannot find appropriate employment. There are no other job opportunities in our region, so they have to migrate to other parts of Zanadu. I heard of a family that ended up in Lapa as trash pickers at the garbage dump."

"Our grandmother states that years with a serious lack of drinking water are much more frequent than during her youth. We now often have situations when the village wells do not provide sufficient water. We have to buy water from passing trucks, but they demand prices that the poorer families cannot afford."

"A pilot initiative by the regional government in one part of Talaran District has invested in improving the use of surface water and protecting against erosion though the use of cover crops and rock lines. After three years, the soil retention and fertility have improved. Farmers are able to cultivate onions and tomatoes throughout the dry season."

"Nowadays it rains less often and you never know when the rains will come. But then, if it does rain, the heavy rains wash away the soil and destroy our fields. If you farm millet, you're at a loss – this crop cannot tolerate rain at inappropriate times."

"A nearby community has formed an artisan's group and is selling vessels made with local materials to a craft market in Talaran. They have pooled a percentage of their earnings into a small fund for things that benefit all members."

Module 9:
Take action at local level and beyond

Apply a climate lens
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for this exercise

Understand what can be done at the local level and how local action links to regional and national governance and other actors.

Context

The District Government is conducting a stakeholder workshop to focus on climate change issues relevant to sustainable district development. The common aim is to sustainably manage natural resources in Talaran District. The workshop's objective is to identify adaptation options depending on which stakeholders become more resilient to climate variability and change. Stakeholder groups have been invited to share their perspectives and to join forces. Given concrete results, there is an opportunity for coordination with relevant actors and networks at state and national level.

Instructions for case work

- You are participants at the workshop.
- The workshop is ongoing.
  In the first session, local climate change vulnerabilities have been defined. They are based on a briefing of anticipated climate change in the Talaran District by Hydromet. (For climate information see Introduction to the West State, p. 49).
- Matrix 14 assists the common analysis of vulnerabilities and adaptation options.

Your task

- Use Matrix 14 to guide your work. Column A shows the vulnerabilities that have been defined in the first workshop session.
- In **column B** discuss what adaptation options are possible.
  (See Graph 3, p. 31, for more information on vulnerability functions.)
  First brainstorm broadly and then select the most relevant options.
- In **column C**, define which steps are necessary to put the options into practice.
- In **column D** specify the actors with capacities to take action or contribute to solutions. Think of synergies with – and support needed from – actors at state and national level as well as non-state actors.
  E.g. pastoralist communities are experienced with keeping livestock under difficult circumstances; new knowledge about other breeds may help to broaden the horizon of options. OR: participatory land use planning at district level could help to avoid land use conflicts.

Matrix 14: Assess vulnerabilities and adaptation options at local level

A Vulnerabilities to climate change in Talaran district	**B Adaptation options**	**C Next steps**	**D Who has the capacity to take action?**
Pastoralists have to deal with loss of grazing areas due to overuse of lands and drought.	• *Change of breeds, animals* • *Income diversification*	• *Find out which breeds are adapted to future climate conditions* • *Market analysis: products? prices? resources needed?*	• *Agric. ext. services (implementation); Univ. of Lapa, Dept. Animal husbandry (breeds)* • *Local community; expert support on value chain marketing*
Women cannot find enough water, as there is less available in wells due to reduced groundwater recharge and over pumping.			
Farmers face reduced harvests due to changes in precipitation and lack of heat and drought-tolerant crops.			
The local community's food security is at stake due to declining production due to drought, late rains and little alternative income.			
Children's development is at risk as their schooling becomes discontinuous due to the increased need for their labour force at home.			

Module 10: Integrate adaptation into the project cycle

Apply a climate lens
Interpret climate data
Four-step approach: (1) Assess vulnerability
Four-step approach: (2) Identify adaptation options
Four-step approach: (3) Select adaptation measures
Four-step approach: (4) Develop an M&E framework
Develop institutional capacity for adaptation
Local climate stresses, vulnerability and resilience
Take action at local level and beyond
Integrate adaptation into the project cycle

Learning objective for this exercise:

Understand how to integrate adaptation into the various steps of the project cycle in order to avoid maladaptation and ensure that the project/programme continues to address priority development needs.

Context

The Government of Zanadu, often in cooperation with bilateral and multilateral agencies, is implementing a number of sustainable development projects in different sectors. As climate change becomes a more and more pressing issue, the Government has asked an expert group for methodological support on how to integrate climate change adaptation into existing and future projects. This will help to avoid misguided investments and ensure that the projects continue to address priority development needs under climate change.

Introductions for case work

- You are an expert group that has been asked to support the Government of Zanadu in developing a systematic approach to assess the development projects/programmes in the country in the view of climate change.
- **Part 1**: you advise the government on integrating climate change adaptation into the project cycle in general.
- **Part 2**: you advise individual ministries on integrating adaptation into specific projects.

Part 1: Entry points for adaptation in the project cycle

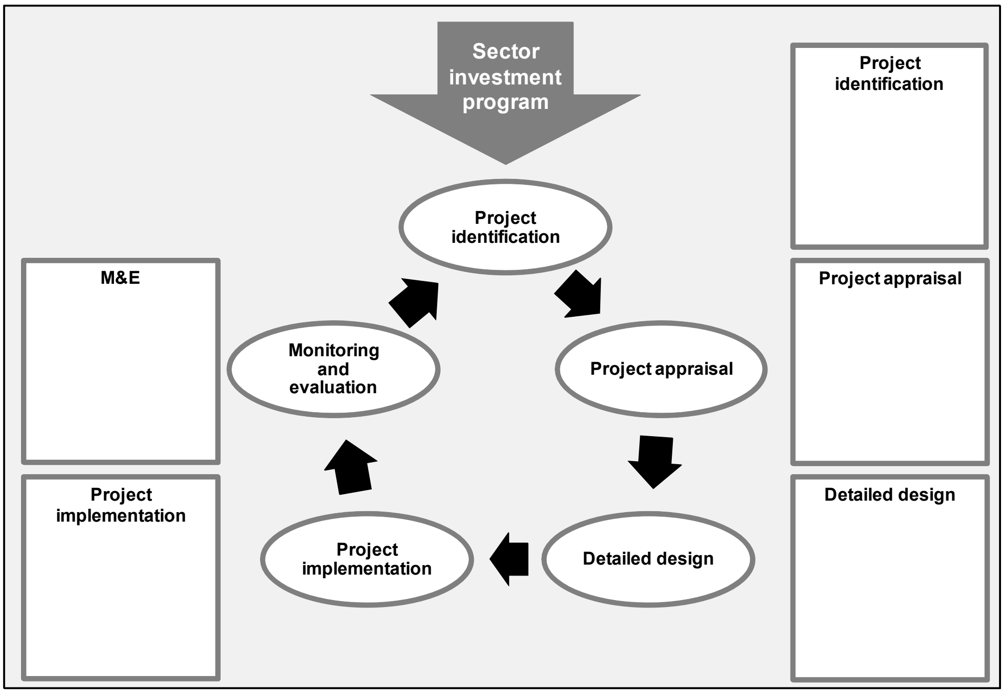
Your task

- You advise the government on integrating climate change adaptation into the project cycle in general.
- Check the glossary to understand the terminology used in this specific project cycle figure.
- Use Matrix 15 to guide your work.
    - Consider at what stage in the project cycle the questions in Exhibit 8 are relevant.

Exhibit 8: Guiding questions for integrating adaptation into development projects

1 What are the climate risks?
2 How can the project become more climate-resilient?
3 Where is climate information needed?
4 Is adaptive management successfully integrated into the project?

Matrix 15: Introduce adaptation in the project cycle



(Source: OECD policy guidance, adapted)

Part 2: Integrating adaptation into a Zanadu project example

You are now advising government ministries on integrating adaptation into their projects.

Your task

- As a hired expert you need to be able to give insightful advice. Therefore, try to get into the ‘shoes’ of a project manager (take advantage of Box 6).
- In this respect review the given project brief.
- Use Matrix 16 to guide your work.
    - Note the project’s objective on top of the page to keep it in mind.
    - With the **1st question** screen if climate change will have likely impacts on the project’s objectives and activities.
    - With the **2nd question** check if the project’s activities might (inadvertently) increase vulnerability.
    - With the **3rd question** discuss opportunities for the project to enhance beneficiaries’ adaptive capacity and thus decrease vulnerabilities.
    - With the **4th question** examine if and how the project’s objectives and activities can benefit from climate change.
- In Matrix 17 determine at what stage in the project cycle you are.
- In Matrix 18 develop suggestions on how to integrate adaptation into the project at this stage and the following steps.
    - You may find it useful to use relevant climate data for decision-making processes (see Annex p III).

It is important for project managers to know

Influence of CC on the project:

- Are the objectives of the project and/or specific activities threatened by climate change?
- Could the project’s objectives and/or activities benefit from climate change?

The project’s influence on the vulnerability of relevant natural or human systems:

- Could my project (inadvertently) increase the beneficiaries’ exposure or sensitivity?
- Could my project contribute to the project beneficiaries’ adaptive capacity?

Ways forward:

- How can project activities leading to reduced vulnerability, i.e. greater adaptive capacity or reduced sensitivity or reduced exposure, be maximised?
- Which activities need to be modified to avoid an increase in vulnerability?
- Which additional activities are required to avoid adverse impacts of climate change on the project?

Box 6: Questions to ask as a project manager when dealing with CC

Matrix 16: Assess a Zanadu project

Project goal / objective: ______________________________

1. Could climate variability and change have adverse effects on the project's objective or activities?

No ☐

Yes ☐ How? ______________________________

____

____

2. Could the project's objective or activities increase exposure or sensitivity of the project beneficiaries?

No ☐

Yes ☐ How? ______________________________

____

____

Risks

3. Could the project's objective or activities contribute to the beneficiaries' adaptive capacity?

No ☐

Yes ☐ How? ______________________________

____

____

4. Could the project's objective or activities benefit from climate change?

No ☐

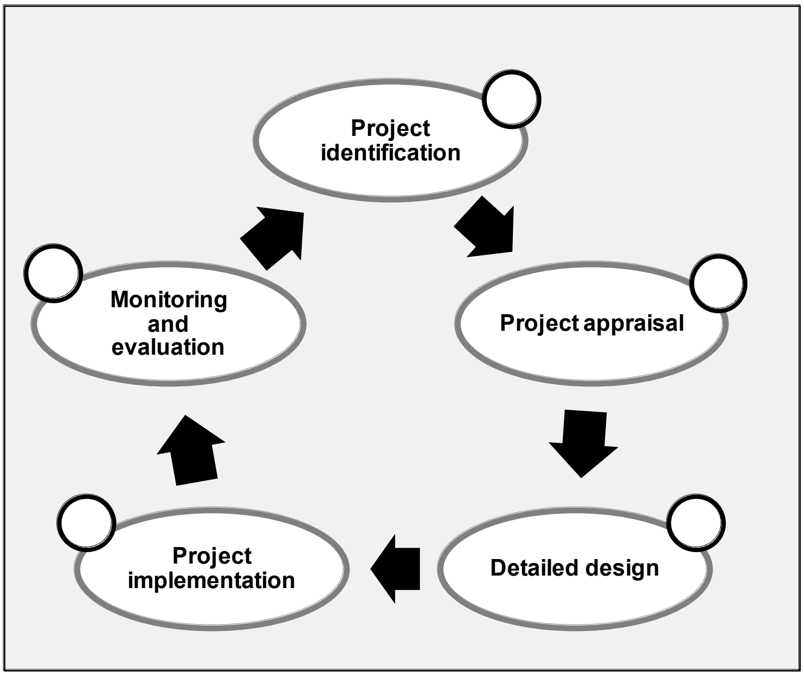
Yes ☐ How? ______________________________

____

____

Opportunities

Matrix 17: Where in the project cycle is the project?



Matrix 18: Suggest adaptation activities for a Zanadu project

Think of activities reducing vulnerability (i.e. reducing exposure and sensitivity and/or enhancing adaptive capacity) or maximising opportunities from climate change.

1 Which steps are required at this stage?
2 What should be considered for the following steps in the project cycle?
3 Which are practical implications of your suggestions (time, information/expertise required, costs)?

► 1. 2. 3.
► 1. 2. 3.
► 1. 2. 3.
► 1. 2. 3.

Annex

Selected PRA Tools

This list[9] is not exhaustive. Additional tools of Participatory Rural Appraisal (PRA) can be discussed within your groups.

Seasonal Calendar

A seasonal calendar provides a common representation of the variability of pressures on livelihoods throughout the year. An extended version of the crop calendar might represent all of the major changes within the rural year, such as rainfall patterns and other major climatic changes, cropping, livestock cycles, labour demand, etc. This helps in identifying lean periods for resources and in timing the supply of farm inputs and alternative employment initiatives. In some areas, people are more familiar, comfortable and accurate using locally relevant cropping or religious benchmarks than the Western calendar. Seasons and months can be related to festivals and livelihood activities that are known and generally celebrated by the majority of the local population.

Visual History

Long-term changes in rural areas can be represented in diagrams such as historical profiles and graphic time trends. Local people's accounts of the past, of how things close to them have changed - ecological histories, land use and cropping patterns, customs and practices, trends in fuel use, etc. - can be represented with approximate dates before and after well-known events. The combination of local perspectives with secondary information sources can improve the design of local development initiatives.

The image of a winding river on poster paper or a chalk board may be a useful way to visually represent a community's history. Important years may be indicated along the course of the river, and the influences of important events reflected in the characteristics of the river and noted alongside changes in its width, depth, direction, health or degradation.

An historical transect depicts local knowledge of the state of natural resources over a period of time. This can be done for various sectors of the rural economy to produce a series of diagrams reflecting people's perceptions and priorities about changes in natural resources, which are so closely linked to livelihoods.

Mapping

Community mapping can provide useful local input to the design of village plans. People can draw maps of their village and locate the services, facilities and infrastructure according to availability and access to different groups, thus facilitating the identification of needs, problems and solutions. Different village groups can draw different maps to depict their perceptions, problems and needs. A number of maps by all sections of people in a village can help in prioritising and preparing village plans of action.

People in the village can draw maps on the ground, floor or on paper (these can later be transferred to paper by the facilitator/PRI actor). Social, demographic, health, natural resources or farm maps can be drawn to construct three-dimensional models of their land. Some examples of such maps constructed by villagers are shown as illustrations in this section. The part to be played by

[9] Text adapted from Jain, S.P. and Polman, W., 2003. *A handbook for trainers on participatory local development: the Panchayati Raj model in India*. Second edition. See Annex II. http://www.fao.org/docrep/007/ae536e/ae536e08.htm

the decentralised development actors in this exercise is that of patient listening and motivating people to participate by accepting and respecting their knowledge.

Transect

Can be used to substantiate and support a map. A transect is a systematic walk with villagers through the village, observing, listening to villagers' descriptions, asking relevant questions, discussing ideas, identifying different zones, local technologies, introduced technologies, seeking problems, solutions and finally, diagramming/mapping the transect walk and its findings. This helps to:

- build rapport with local people;
- substantiate and support the diagrammed facts; and
- identify locations of the problems and opportunities for development.

Venn diagram

A Venn diagram shows the relationship between individuals, groups and institutions in a community as perceived by the people. The diagram is made up of touching or overlapping circles of various sizes, with each circle representing an individual or institution, as appropriate to the situation. The size of each circle indicates its importance or influence and the overlap indicates the degree of contact, interaction or involvement in decision-making. Venn diagrams may help in the formulation and implementation of initiatives at the local level, indicating where key interactions exist or are absent, as well as in identifying marginalised individuals/groups in the community.

Prioritisation matrix

A matrix can be used to involve people in prioritising local needs. Using a common matrix, community members vote using seeds, stones or other appropriate 'votes' to give scores to different development needs or actions, either individually scoring or in small groups and aggregating across the community. Group prioritisation can facilitate a democratic process of prioritisation, ensuring people's involvement in planning. This is useful for micro-planning at village level.

Interviews

Interviews can be conducted in a way that is structured (using set questions) or semi-structured (focused on key topics) with individuals or small groups, as appropriate to the community and purpose. Interviews allow planners to identify the factors contributing to stresses on livelihoods for particularly vulnerable groups within a community, as well as gather local perspectives on development and environment challenges and potential solutions. Important opportunities and barriers may be identified in interviews, for example, access to resources and social services. Interviewers should ensure that questions are designed using neutral, open-ended language to avoid biasing responses.

Climate change information sources

This section contains selected information on climate change tools, data, platforms and guides.

Tools

- **ADAPT** (Assessment and Design for Adaptation to Climate Change) by the World Bank: A Prototype Tool – This multi-sector computer-based tool conducts a sensitivity analysis for specific projects, and is targeted to development practitioners. http://www.go.worldbank.org/AWJKT60300
- **CEDRA** (Climate change and Environmental Degradation Risk and Adaptation Assessment) by Tearfund. A field tool which helps agencies working in developing countries to access and understand the science of climate change and environmental degradation and compare this with local community experience of environmental change. Adaptation options are discussed and decision-making tools are provided to help with planning responses to the hazards identified. CEDRA includes integrating Disaster Risk Reduction responses as relevant existing forms of adaptation. http://tilz.tearfund.org/Topics/Environmental+Sustainability/CEDRA.htm
- **Climate Assessment by GIZ**: (a) Climate Proofing = systematic climate risk reduction & increase of adaptive capacity; (b) Emission Saving = systematic maximisation of contributions to GHG reductions. Tool to assess whether project goals are threatened by climate change and identify adaptation measures within the scope of the project; and identify climate-friendly way of achieving project goal.
- **CRiSTAL** (Community-based Risk Screening Tool – Adaptation and Livelihoods) by IISD. Tool for community scale vulnerability assessment and adaptation planning. Specifically to (a) Understand the links between livelihoods and climate in their project areas; (b) Assess a project's impact on community-level adaptive capacity; and (c) Make project adjustments to improve its impact on adaptive capacity and reduce the vulnerability of communities to climate change. Users can follow this process through a Microsoft Excel interface or by reading the accompanying document (User's manual). http://www.cristaltool.org/content/download.aspx
- **Global Adaptation Atlas** by Resources for the Future, a dynamic climate change impact mapping tool. The Atlas brings together diverse sets of data on the human impacts of climate change and adaptation activities across the themes of food, water, land, health and livelihood to help researchers, policymakers, planners and citizens to establish priorities for action on adaptation. http://www.adaptationatlas.org/index.cfm

Climate Data

- **World Bank climate change data portal**: Provides an entry point for access to climate related data and tools. The Portal provides access to comprehensive global and country data information related to climate change and development and intends to serve as a common platform to collect, integrate and display climate change relevant information at the global scale. http://sdwebx.worldbank.org/climateportal/home.cfm?page=globlemap
- **The Nature Conservancy Climate Wizard** allows users to map historic climate data as well as downscaled projections for the globe (switch to global). http://www.climatewizard.org/
- **CI:grasp** (Climate Impacts: Global and Regional Adaptation Support Platform) is a layered platform providing knowledge about regional climate forcings, its related impacts and systematic regional vulnerability assessments. As sound information basis for decision-makers and development experts it also provides adaptation expertise and combines top-down and bottom-up approaches. http://cigrasp.pik-potsdam.de/session/new
- **IPCC Data Visualization**: Part of the Data Distribution Centre (DDC) of the Intergovernmental Panel on Climate Change (IPCC). The DDC provides climate, socio-economic and environmental data, both from the past and also in scenarios projected into the future. Technical guidelines on the selection and use of different types of data and scenarios in research and assessment are also provided. The DDC is designed primarily for climate change researchers, but materials contained on the site may also be of interest to educators, governmental and non-governmental organisations and the general public. http://www.ipcc-data.org/maps/

Platforms

- **Climate 1-Stop** provides a single location to access climate change tools, resources and information. Users can upload and share materials: http://www.climate1stop.org
- **Adaptation Learning Mechanism** (ALM) with case studies, publications, country profiles, open to user submissions: http://www.adaptationlearning.net
- **weAdapt** is an adaptation wiki for sharing experience: www.weadapt.org
- **Community Based Adaptation Exchange**, a platform for exchanging news, events, case studies, tools, policy resources and videos: http://community.eldis.org/.59b70e3d/

Glossary

Adaptation

IPCC (2001) defines adaptation as adjustments in human and natural systems in response to actual or expected climate signals or their impacts, that moderate harm or exploit beneficial opportunities.

This consists of a variety of behavioural, structural and technological adjustments. Activities vary

- in their timing (ex-ante vs. ex-post)
- in their scope (short-term vs. long-term; localised vs. region-wide)
- in their strategy (autonomous vs. planned; passive vs. active)
- in their agents (private vs. public; societies vs. natural systems)

In order to distinguish 'adaptation' from to 'regular development activities', the Guidance describes a continuum of four different levels of activities from development to climate change adaptation (reference to WRI 2007):

1. Activities that increase human development and address drivers of vulnerability, e.g. gender initiatives, livelihood enhancement efforts.
2. Activities that build response capacity, often in directly affected sectors, e.g. natural resource management, weather monitoring.
3. Activities that aim at managing climate risks, mostly through strategic use of climate information, e.g. disaster response planning, drought resistant crops.
4. Activities that confront climate change by addressing concrete impacts, e.g. relocation of communities in response to sea-level rise.

Adaptive capacity

Adaptive capacity is a system's ability to adjust to climate change and variability, to moderate potential damage, to take advantage of opportunities or to cope with consequences.
Adaptive capacity is a function of the relative level of a society's economic resources, access to technology, access to climate information, skills to make use of the information, institutions and equitable distribution of resources.
Adaptive capacity tends to be correlated with the level of development: more developed countries and communities tend to have more adaptive capacity.
(OECD based on IPCC)

In ecosystems, adaptive capacity is influenced by biodiversity (genetic, species, etc.). In social systems adaptive capacity is determined by the individual and/or common ability to cope with change (the ability to learn, manage risks and impacts, develop new knowledge, and devise effective approaches) and the institutional setting (IUCN).

(-> see Graph 3: Vulnerability functions)

Adaptive management	Adaptive management is a structured, interactive process of decision-making in the face of uncertainty, with an aim to reducing uncertainty and improving performance over time: system monitoring, evaluating results and adjusting actions on the basis of what has been learned. *Passive adaptive management* values learning only insofar as it improves decision outcomes. *Active adaptive management* explicitly seeks learning experiences.
Climate change	Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. (IPCC 2001) This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.
Climate (change) scenario	A plausible and often simplified representation of the future *climate*, based on an internally consistent set of climatological relationships and assumptions of *radiative forcing*, typically constructed for explicit use as input to climate change impact models. A 'climate change scenario' is the difference between a climate *scenario* and the current climate.
Climate stresses	Climate stresses are climate extremes to which the system and its components are exposed, e.g. variable temperature and rainfall, cyclical flood, drought, storms, etc.
Coping capacity	Coping capacity is the ability of a system to withstand climate stresses. It does not imply adjustment and change as with adaptive capacity, but rather the ability to endure the impacts.
Ecosystem-based approaches	Ecosystem-based approaches to adaptation use biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change. Ecosystem-based approaches to adaptation use the range of opportunities for the sustainable management, conservation and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. (CBD AdHoc Technical Expert Group on Biodiversity and Climate Change)

Emission scenario

A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g. *greenhouse gases*, *aerosols*) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socio-economic development, technological change) and their key relationships (IPCC 2007).

IPCC Special Report on Emissions Scenarios (SRES, 2000) works with different scenarios – to date they were all considered equally sound.[10]

A1 describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T) or a balance across all sources (A1B).

A2 describes a very heterogeneous world. The underlying theme is self reliance and preservation of local identities and a continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1 describes a convergent world with the same global population that peaks in mid-century and declines thereafter, with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability.

B2 describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population (at a rate lower than A2), intermediate levels of economic development and less rapid and more diverse technological change than in B1 and A1. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

Exposure

Exposure represents the important climate events that affect a system. In practical terms, exposure is the extent to which a region, resource or community experiences changes in climate. It is characterised by the magnitude, frequency, duration and/or spatial extent of a climate event. (IPCC 2007, IUCN 2010). (-> see Graph 3: Vulnerability functions)

[10] For more information on the different scenarios used by IPCC see http://www.ipcc.ch/publications_and_data/ar4/wg2/en/spmsspm-e.html

Impact (CC) Impacts are consequences of climate change on natural and human systems. The character and magnitude of an impact is determined by (a) the exposure and (b) the sensitivity of the system. We say *potential* impacts as obviously it is not clear what is going to happen in the future and today's mitigation and adaptation efforts may even prevent their occurrence.

Biophysical impacts refer to the biophysical parts of a system and often directly result from climate change factors, e.g. damaged infrastructure due to flooding or erosion of shorelines due to storm surge.

Socio-economic impacts (for the bigger part) follow biophysical impacts and affect socio-economic development, e.g. reduced access to services due to damaged infrastructure or losses in tourism revenues due to shoreline erosion. (-> see Graph 3: Vulnerability functions)

Impact (M&E) Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended. (OECD 2002)

Indicator Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor. (OECD 2002)

Maladaptation In the OECD policy guidance, Integrating Climate Change Adaptation into Development Co-operation, maladaptation is defined as business-as-usual development, which, by overlooking climate change impacts, inadvertently increases exposure and or vulnerability to CC.

Maladaptation could also include adaptation measures which in the end do not lead to reduced but increased vulnerability because of lack of information, wrong assumptions, ill-devised implementation, side effects, etc.

Model A climate model is a numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes and accounting for all or some of its known properties. There are models of varying complexity (i.e., for any one component or combination of components a hierarchy of models can be identified, differing in such aspects as the number of spatial dimensions, the extent to which physical, chemical or biological processes are explicitly represented, or the level at which empirical parameterisations are involved).

General Circulation/Climate Models (GCM) represent the earth's climate (including atmosphere, oceans and land), coupled with atmosphere/ocean/sea-ice General Circulation Models (AOGCMs) provide a comprehensive representation of the climate system. *Regional Climate Models (RCM)* are used to develop smaller scale climate projections. Models are also developed for other systems to project impacts, such as hydrologic models.

Climate models are applied as a research tool to study and simulate the climate, e.g. develop projections of future climate based on greenhouse gas emissions scenarios, but also for operational purposes, including monthly, seasonal, and inter-annual climate predictions. (IPCC 2001)

No regret option Adaptation actions that benefit development and are justified regardless of climate change.

Observations Measured, experienced weather conditions, e.g. from a weather station.

Outcome The likely or achieved short-term and medium-term effects of an intervention's outputs. (OECD 2002)

Output The products, capital goods and services which result from a development intervention; may also include changes resulting from the intervention which are relevant to the achievement of outcomes. (OECD 2002)

Prediction A climate prediction or climate forecast is the result of an attempt to produce an estimate of the actual evolution of the climate in the future, e.g., at seasonal, inter-annual or long-term timescales.

Project phase "appraisal" Project appraisal is the stage when each discrete project proposal selected is formulated and analysed in more detail and when the viability of the project is evaluated against multiple criteria, e.g. economic, environmental, health, safety, certainty of performance, etc. The results inform the decision regarding the specific form under which the project should be pursued. (OECD)

At this point a climate-risk assessment provides the opportunity to reduce the climate change risks facing a project and to take advantage of any opportunities that may arise from climate change. In addition, this is also the stage where an Environmental Impact Assessment is carried out.

Project phase "detailed design"
Detailed design is the stage when the findings of the appraisal stage can be implemented and the bulk of the project parameters is finalised before implementation. (OECD)

Project phase "identification"
This first step in the project cycle comprises the establishment of indicative objectives, general guidelines and principles for the project, according to policies and strategies. The key output of this stage is normally a logical framework that outlines a set of interventions to be implemented within a specific time-frame and within an allocated budget. Project implementation agencies and management rules and procedures are also indicated. (OECD)

In order to integrate adaptation, the project can be evaluated at this stage to assess whether it is in principle climate-sensitive or whether it may affect the vulnerability of a human or natural system.

Project phase "M&E"
Monitoring serves to identify successes and problems during project implementation, to enable informed and timely decision making by project managers and to assess the accountability for the resources and results achieved. Evaluation has broader scope, i.e. whether or not the right objectives and strategies were chosen, and a different timing, usually at completion or ex post. (OECD)

Projection
A climate projection is the calculated response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based on simulations by climate models.

Projections are distinguished from predictions in order to emphasise that projections involve assumptions – concerning, for example, future socio-economic and technological developments, that may or may not be realised – and are therefore subject to substantial *uncertainty*. (IPCC 2007)

Resilience
The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation and the capacity to adapt to stress and change. (IPCC 2001)

The ability of a social or ecological system to cope and adapt to changes in the environment. In practice building resilience can be considered analogous to decreasing vulnerability. (IUCN 2010)

Results chain
The causal sequence for a development intervention that stipulates the necessary sequence to achieve desired objectives beginning with inputs, moving through activities and outputs, and culminating in outcomes, impacts and feedback. (OECD 2002)

Sensitivity

Sensitivity is the degree to which a system can be affected, negatively or positively, by changes (in climate). Changes may have direct or indirect effects.

In ecological systems, sensitivity is described in terms of physiological tolerances to changing conditions. The sensitivity of social systems depends on economic, political, cultural and institutional factors. These factors can confound or ameliorate climate exposure. (IUCN)

(-> see Graph 3: Vulnerability functions)

System of interest

The 'system of interest' is the unit you chose to assess with respect to your question. You may determine your system of interest at different levels, e.g. a single crop system, an ecosystem, a region – depending on the objective of your analysis. (Imagine looking at your house from different angles.)

Elsewhere, you may find 'system of interest' called 'exposure unit'.

Trend

Changes in climate that show a similar direction over time.
An *observed/historic trend* could be, for example, the later arrival of rainfall over the last five years.
Projected trends give a possible future direction, e.g. decreasing rainfall in summer, and if combined with a data range (decrease of 10 days of rain or decrease of X amount of rain) can help to devise adaptation measures.

Vulnerability

Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change. Vulnerability is a function of exposure to climate stresses, sensitivity and adaptive capacity. Vulnerability increases as the magnitude of climate change (exposure) or sensitivity increases, and decreases as adaptive capacity increases. (-> see Graph 3: Vulnerability functions)

Abbreviations

CC	Climate change
CCA	Climate change adaptation
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
GHG	Greenhouse gas
GoZ	Government of Zanadu
Hydromet	Zanadu National Hydrometeorological Service
IPCC	Intergovernmental Panel on Climate Change
MoA	Ministry of Agriculture
MoW	Ministry of Water Resources
M&E	Monitoring and Evaluation
NDP	National Development Plan
NPC	National Planning Commission
ODA	Official Development Assistance
PRA	Participatory Rural Appraisal
SWA	State Water Authority
SWP	State Water Programme

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