Review of global and regional vulnerability assessments of water resources due to climate change

Mahmoud Medany

The Arab Organization for Agricultural Development

AOAD

Presentation outlines:

1. Vulnerability concept
2. Current global and regional water situation
3. Global and regional water situation & CC
4. Vulnerability example
5. Conclusion

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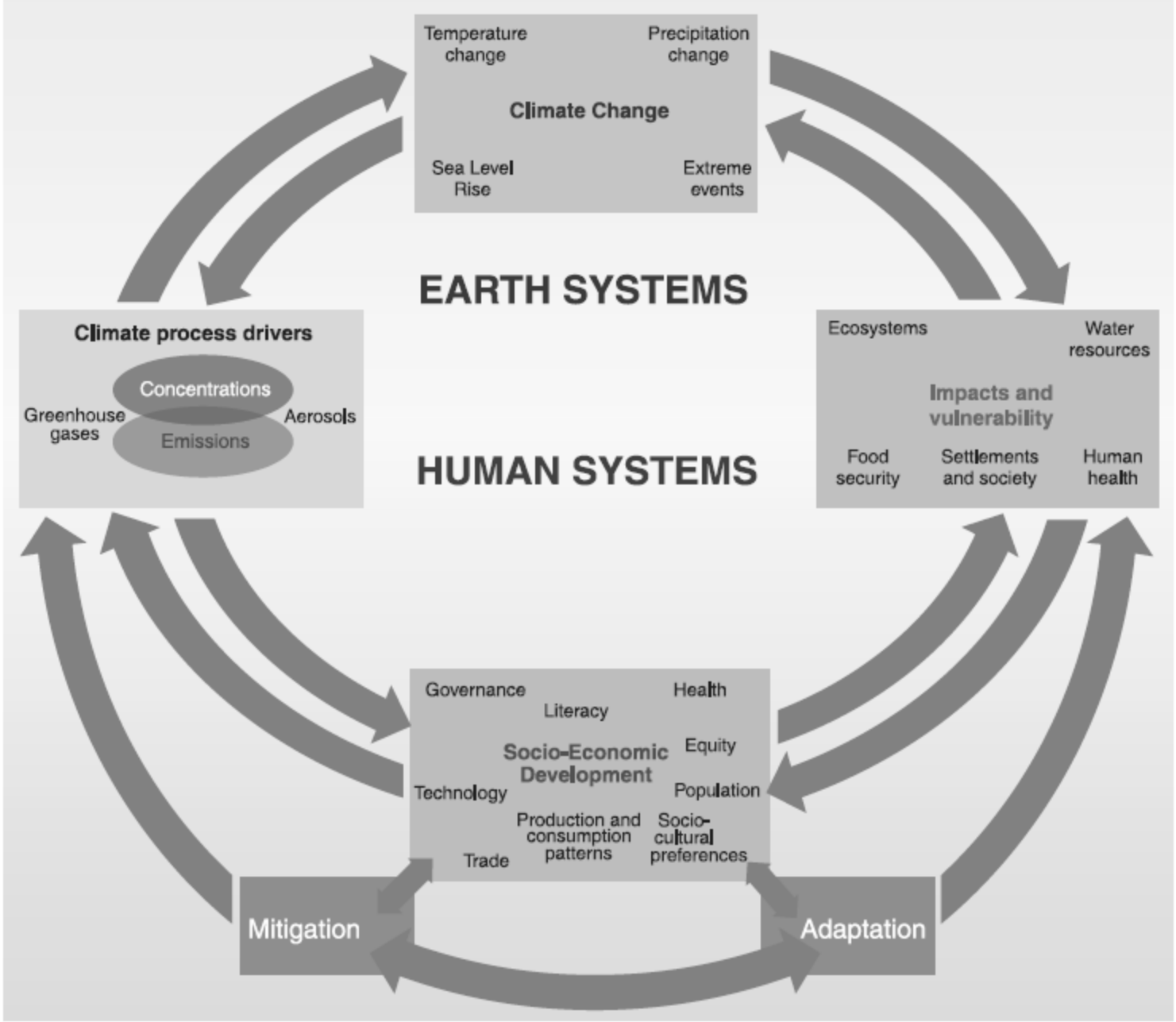


Schematic framework representing anthropogenic drivers, impacts of and responses to climate change, and their linkages.

Vulnerability Definition

Vulnerability *of the systems to climate change****…***

The degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, the adverse impacts of climate change.

Füssel and Klein (2006)

Assessment studies TORs

Assessments of Climate Change Impacts, Adaptation and Vulnerability **(CCIAV)…** are undertaken to inform decision-making in an environment of uncertainty.

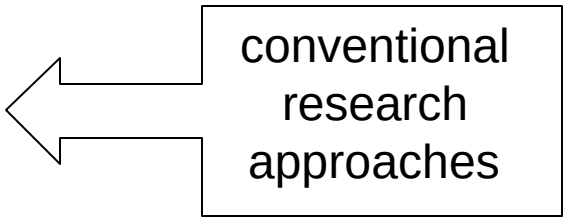
A major aim of CCIAV assessment approaches is **to manage, rather than overcome, uncertainty** (Schneider and Kuntz-Duriseti, 2002), and each approach has its strengths and weaknesses in that regard.

CCIAV concept: the overall scope and direction of an assessment and **can accommodate a variety of different methods**.

CCIV method: a systematic process of analysis.

Assessment studies TORs

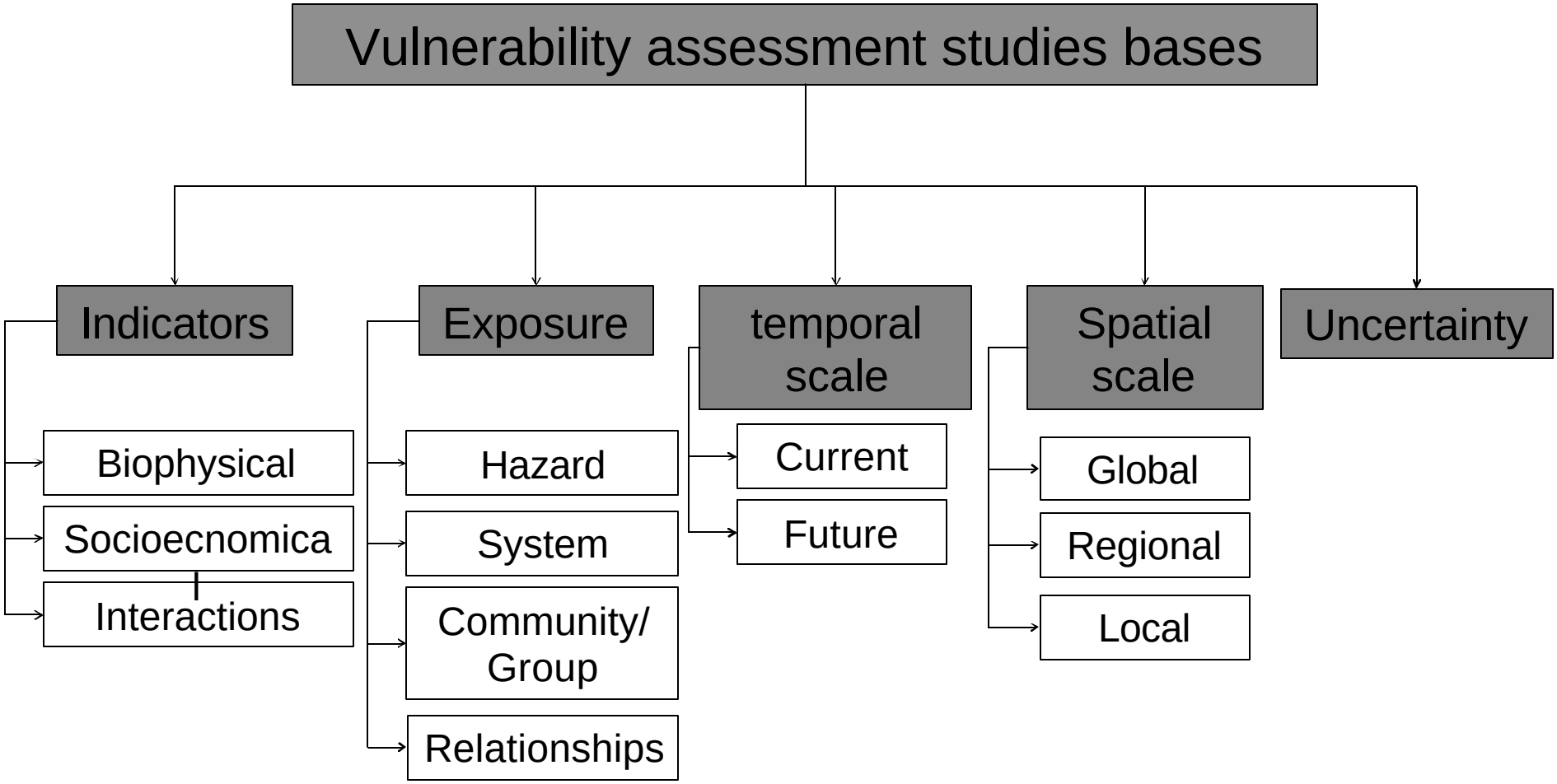
CCIAV five approaches:
1)impact assessment,
2)adaptation assessment,
3)vulnerability assessment,
4)Integrated assessment.



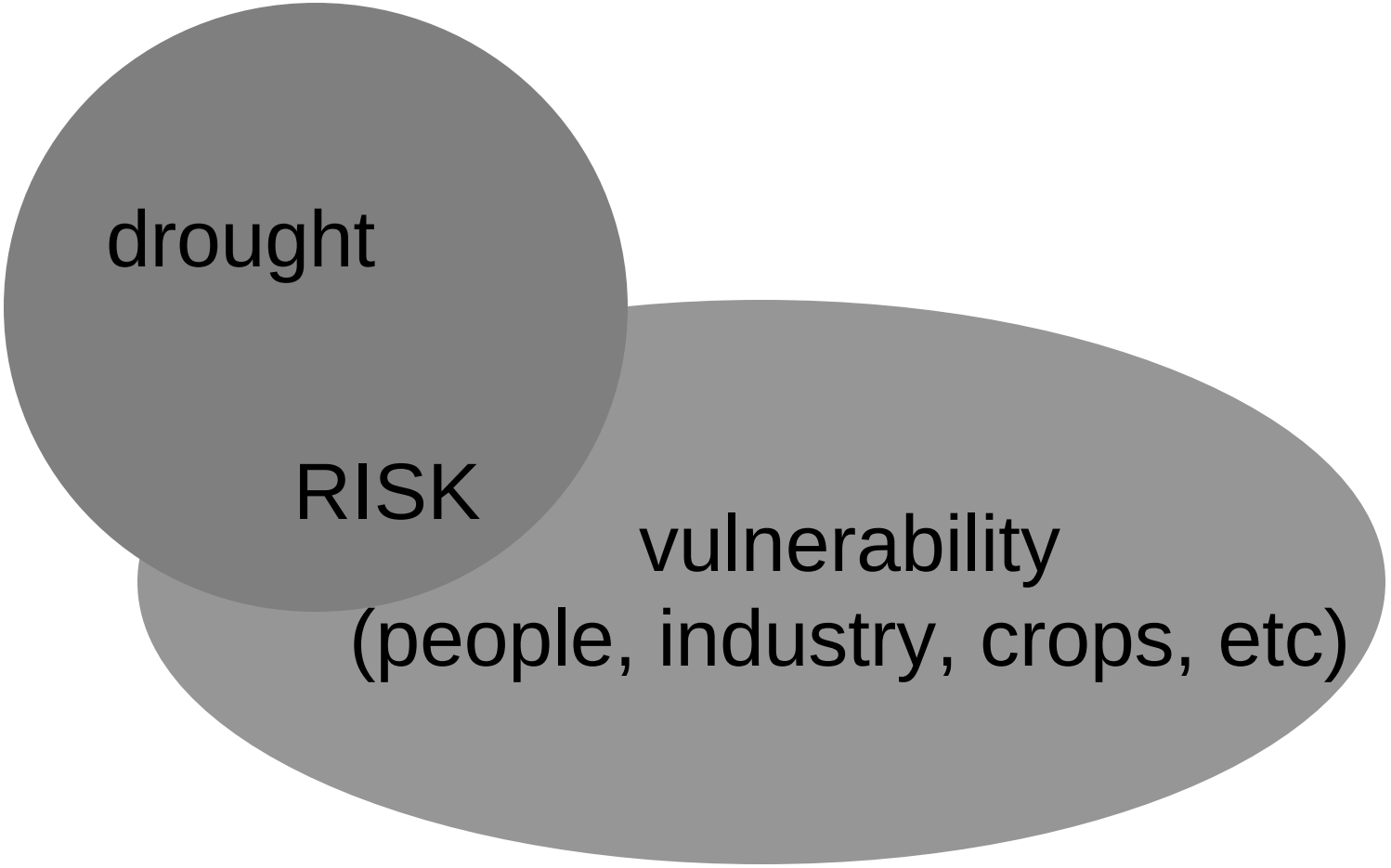
5)risk management, has emerged as CCIAV studies have begun to be taken up in mainstream policy-making.

Most CCIAV approaches have a scenario component

	CCIAV Approach			
	Impact	**Vulnerability**	**Adaptation**	**Integrated**
Scientific objectives	Impacts and risks under future climate	Processes affecting vulnerability to climate change	Processes affecting adaptation and adaptive capacity	Interactions and feedbacks between multiple drivers and impacts
Practical aims	Actions to reduce risks	Actions to reduce vulnerability	Actions to improve adaptation	Global policy options and costs
Research methods	Standard approach to CCIAV Drivers-pressure- state impact-response (DPSIR) methods Hazard-driven risk Assessment	Vulnerability indicators and profiles Past and present climate risks Livelihood analysis Agent-based methods Narrative methods Risk perception including critical thresholds Development/sustainability policy performance Relationship of adaptive capacity to sustainable development		Integrated assessment modeling Cross-sectoral interactions Integration of climate with other drivers Stakeholder discussions Linking models across types and scales Combining assessment approaches/methods
Spatial domains	Top-down Global -› Local	Bottom-up Local -› Regional (macro-economic approaches are top- down)		Linking scales Commonly global/regional Often grid-based
Scenario types	Exploratory scenarios of climate and other factors (e.g., SRES) Normative scenarios (e.g., stabilisation)	Socio-economic conditions Scenarios or inverse methods	Baseline adaptation Adaptation analogues from history, other locations, other activities	Exploratory scenarios: exogenous and often endogenous (including feedbacks) Normative pathways
Motivation	Research-driven	Research-/stakeholder-driven	Stakeholder-/research driven	Research-/stakeholder-driven


Vulnerability assessment studies bases
Indicators
Exposure
temporal scale
Spatial scale
Uncertainty
Biophysical
Socioecnomica
Interactions
Hazard
System
Community/ Group
Relationships
Current
Future
Global
Regional
Local

“[Vulnerability] is an aggregate measure of human welfare that integrates environmental, social, economic and political exposure to a range of harmful perturbations” (UNEP 2001).



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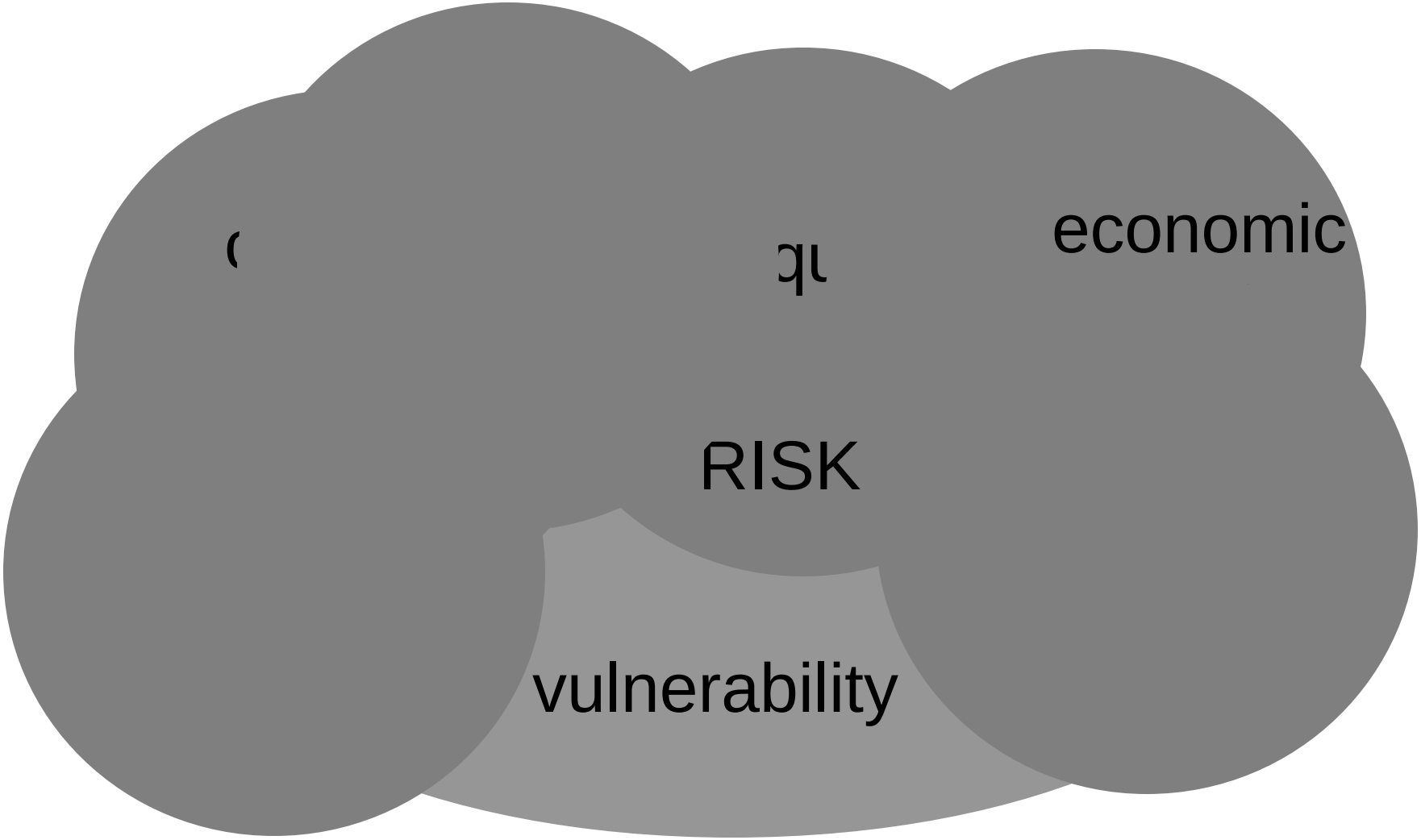
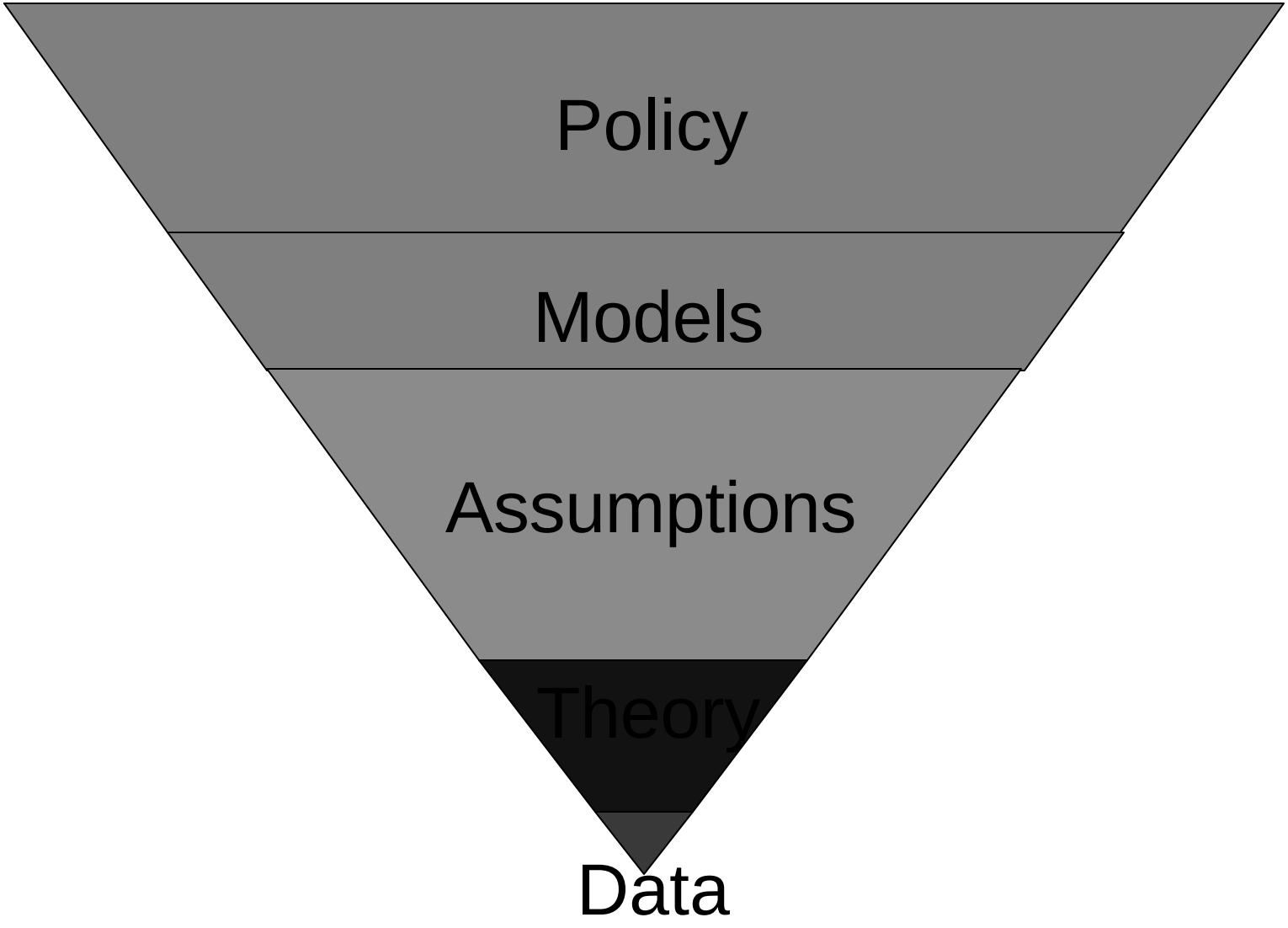


Uncertainty derived from …..



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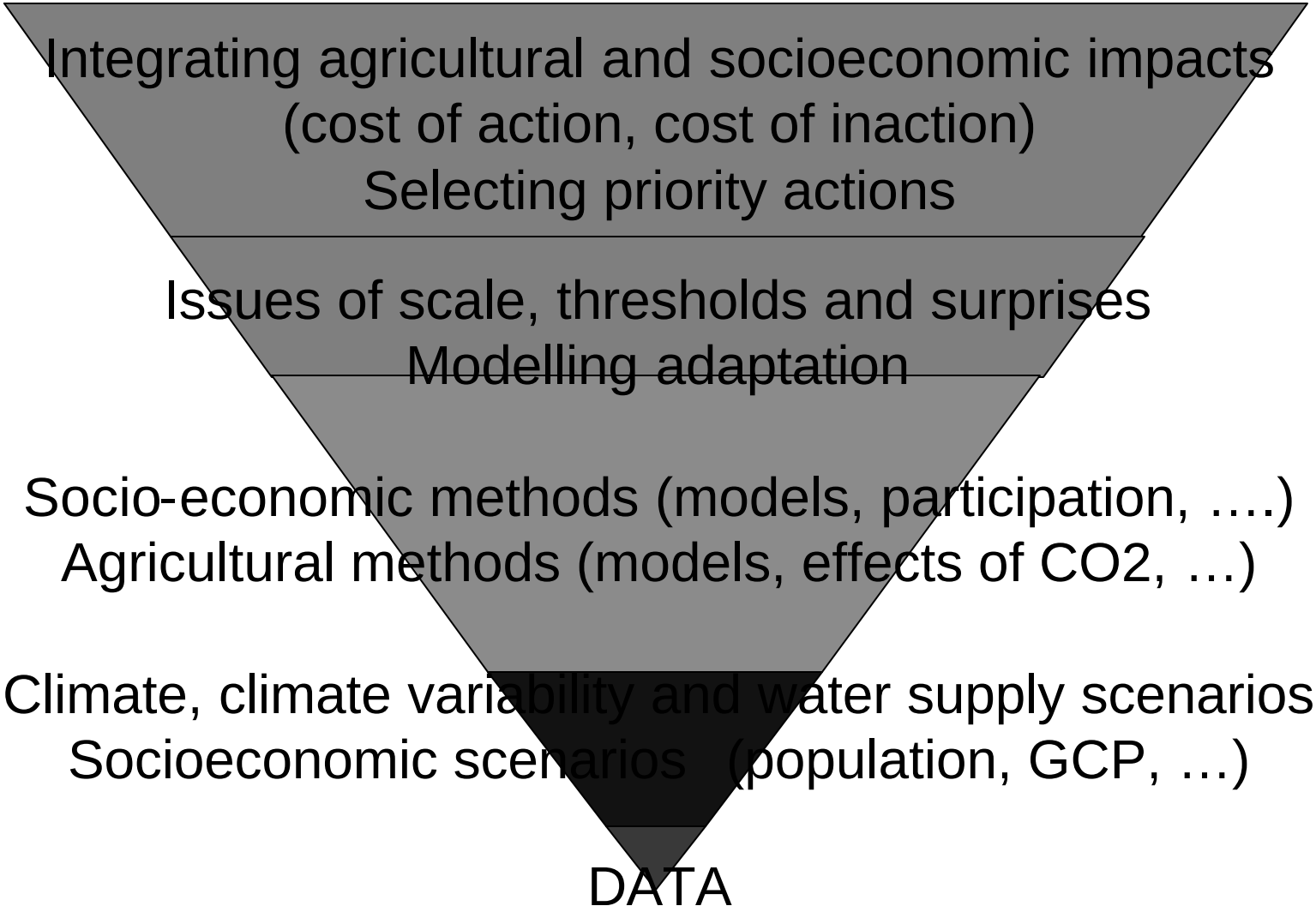

Vulnerability of water resources and management to climate change….

Indicated as….

Water stress/ scarcity

Indicators

- ✓Available global resources
- ✓Distribution of natural water resources
- ✓Water usage profile
- ✓Change in resources under climate change

Exposures

- ✓Population increase
- ✓Food security demands
- ✓Climate change impact on food security
- ✓Social development & wealth equity access
- ✓Unsustainable development
- ✓Change in water usage profile

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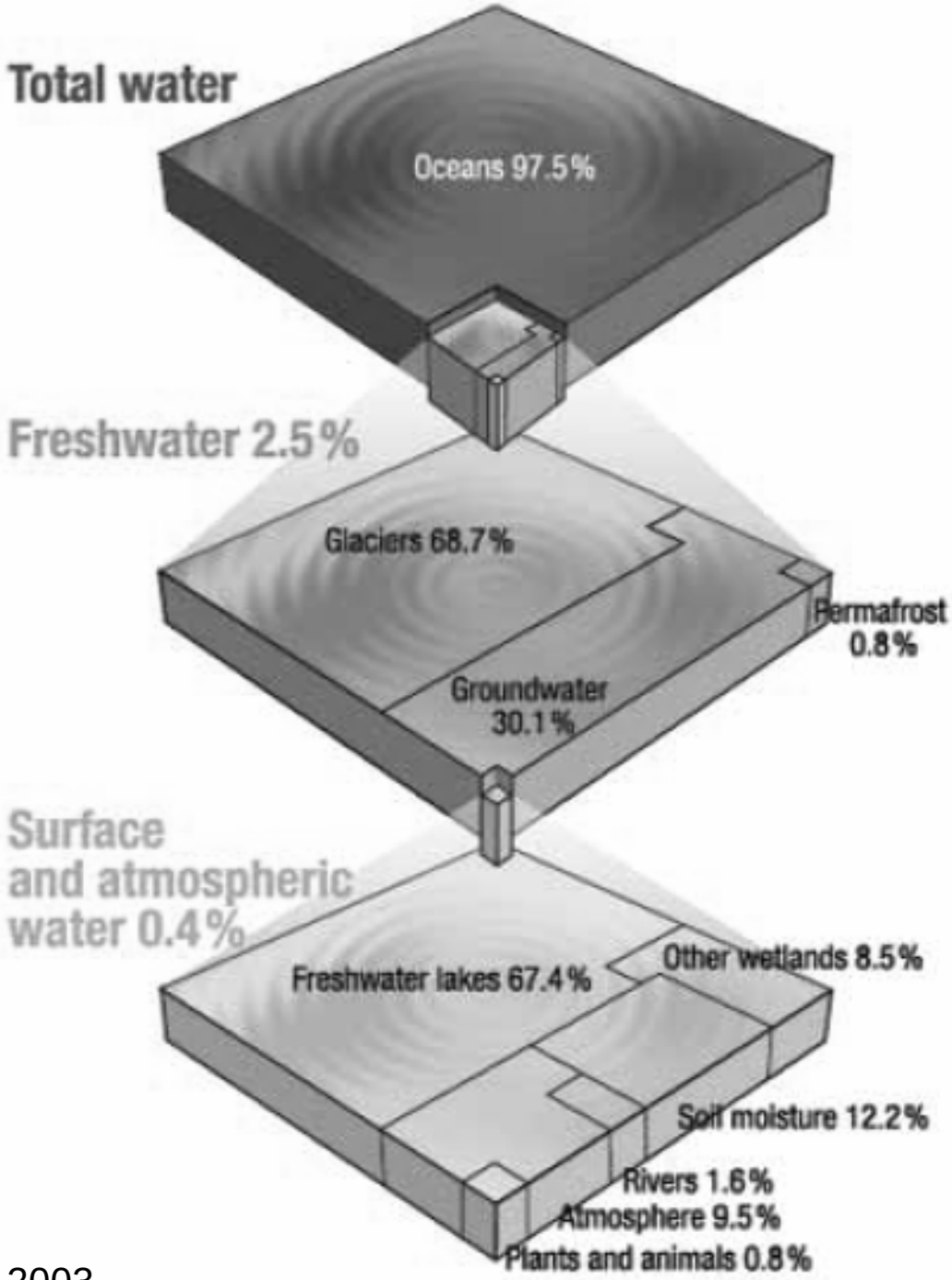
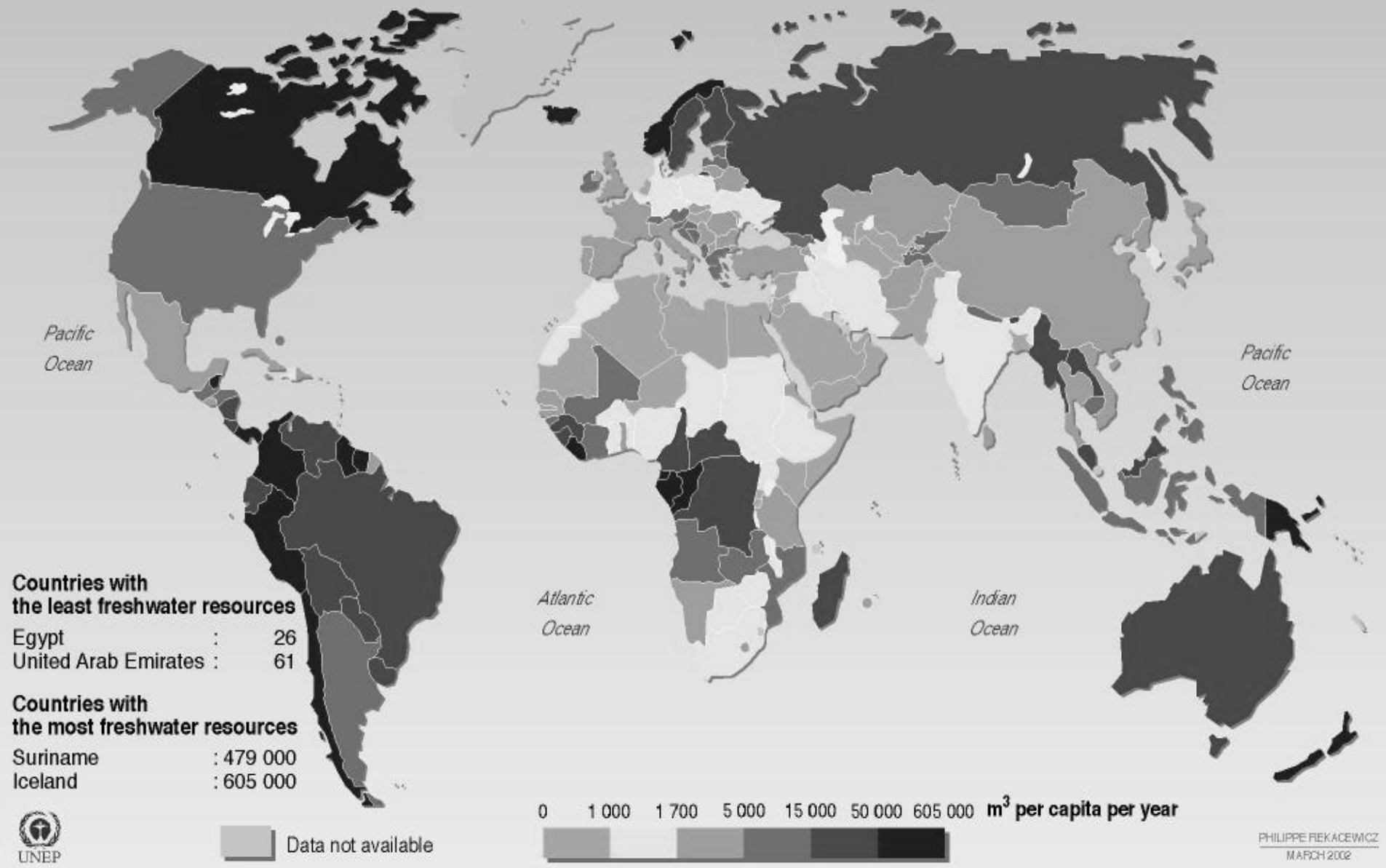
Global water resourc



Source: Data from Shiklomanov and Rodda, 2003.

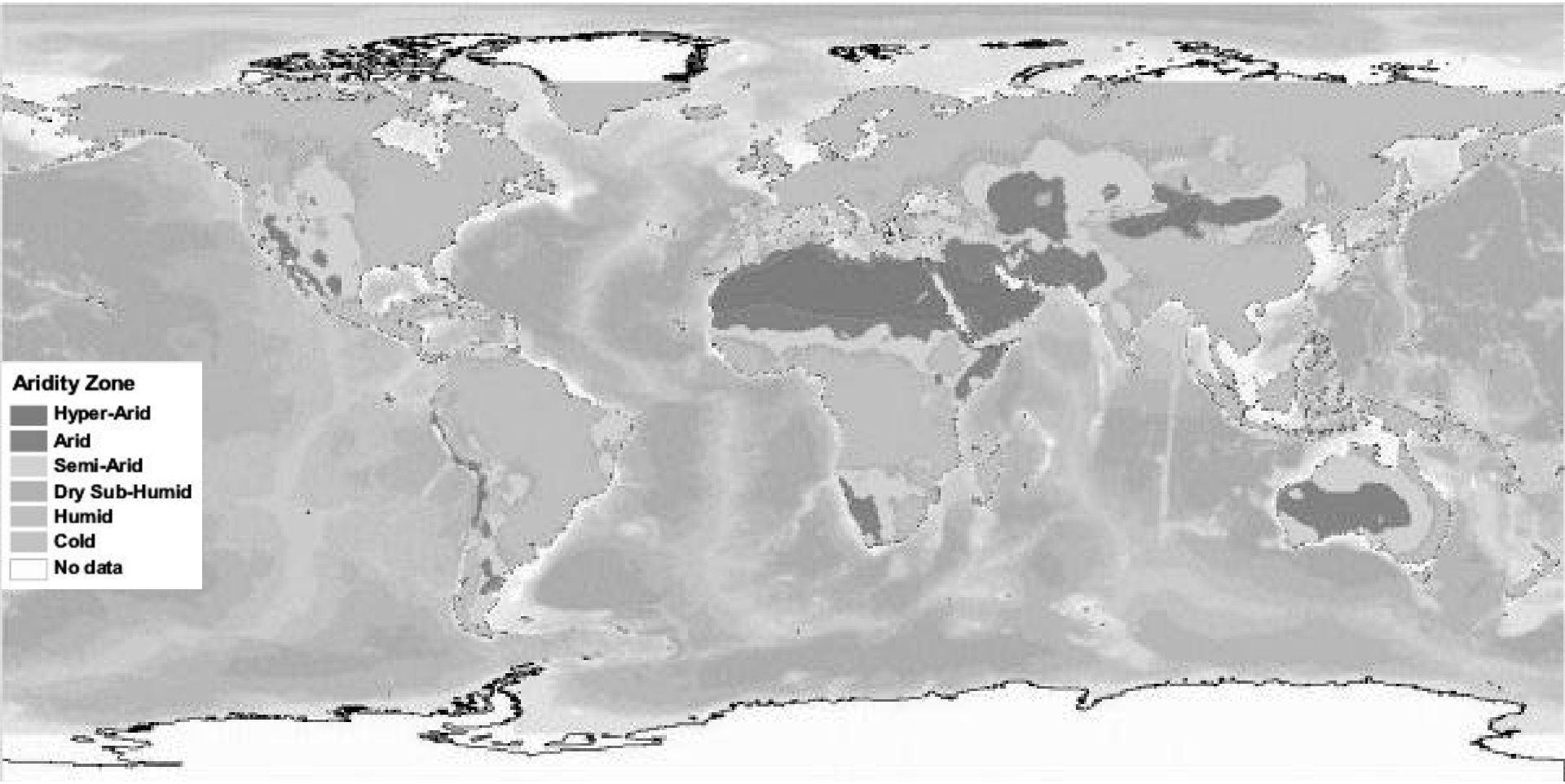
Availability of Freshwater in 2000

Average River Flows and Groundwater Recharge



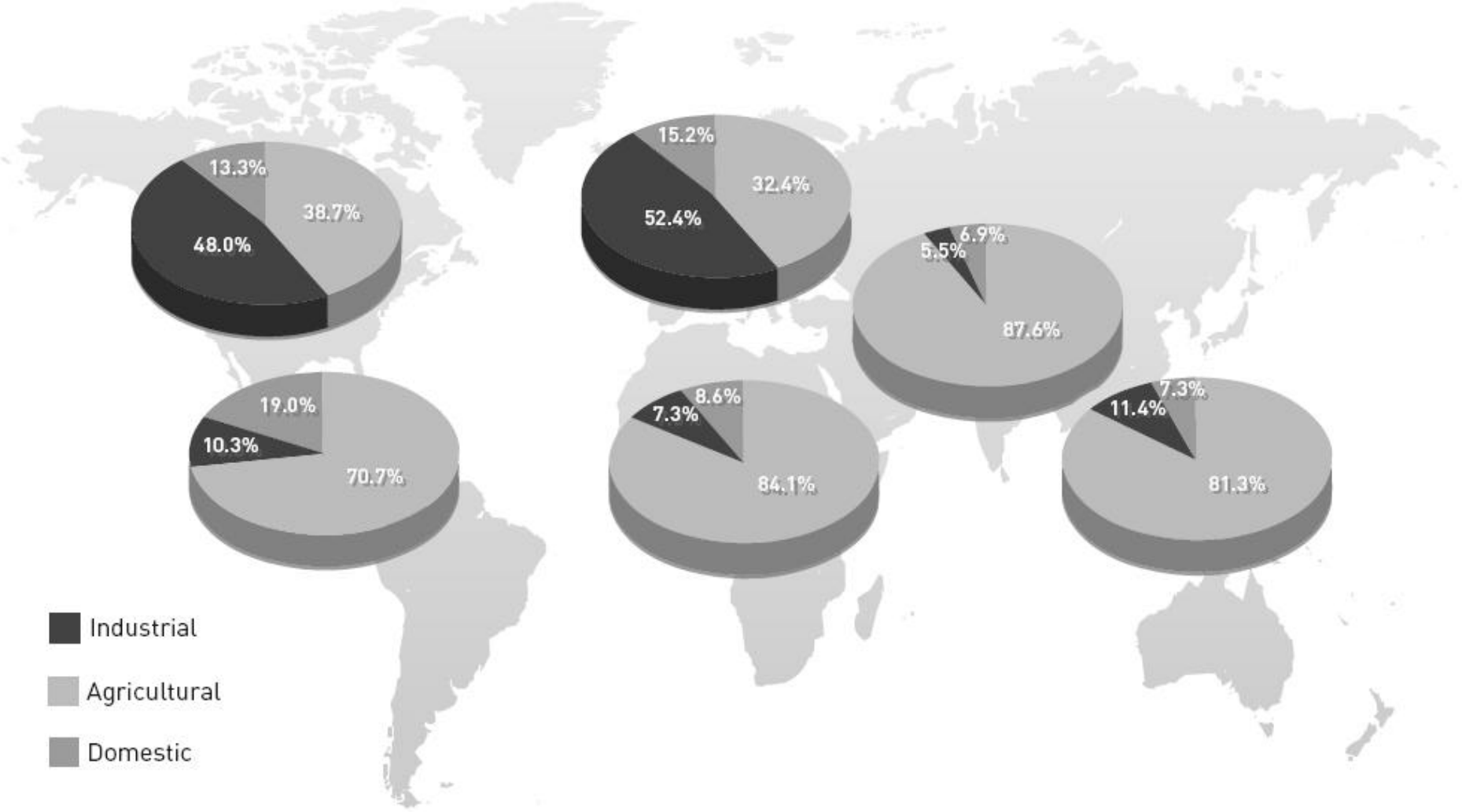
Source: *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000.

Aridity Zones of the World



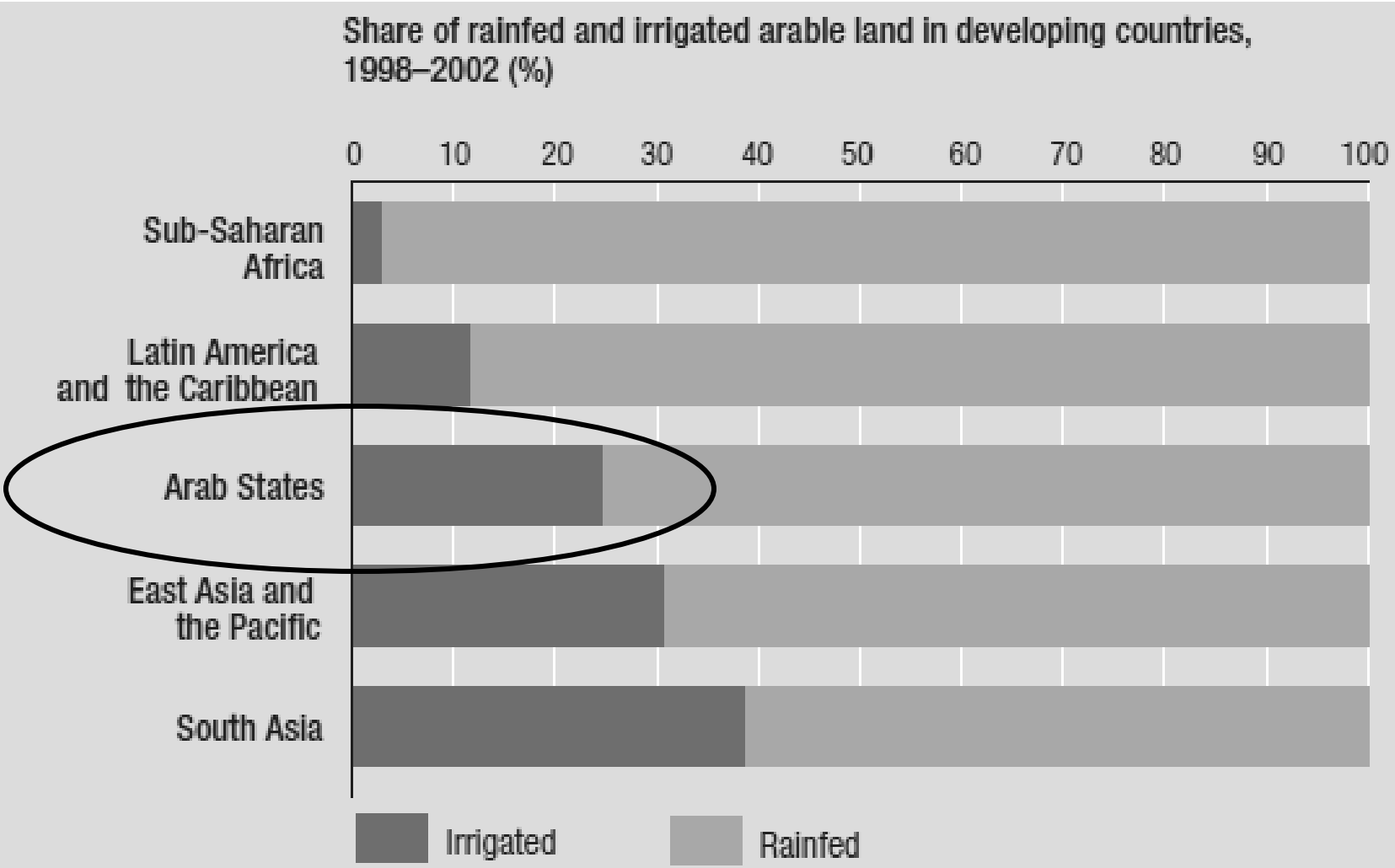
WRI. 2002. World Resources Institute. Drylands, People, and Ecosystem Goods and Services: A Web-based Geospatial Analysis. Available online at: http://www.wri.org.

Water consumption profile



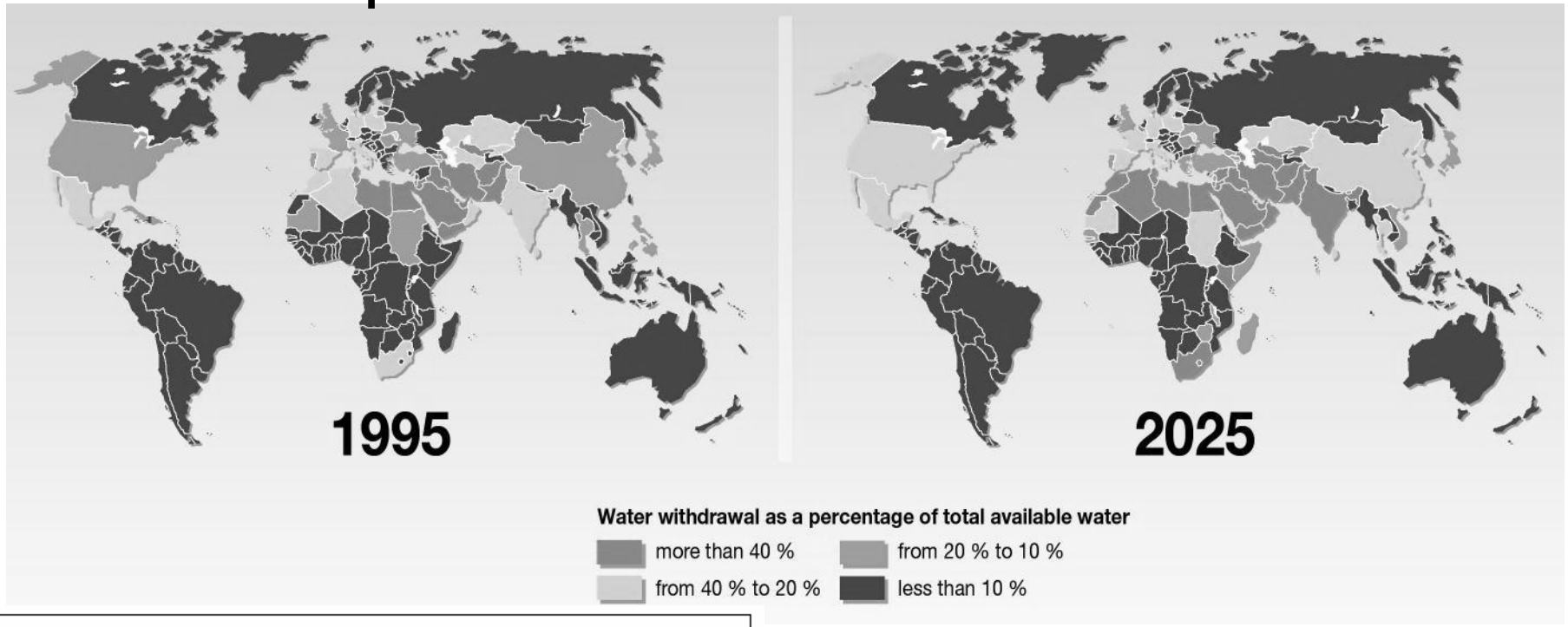
On a world scale, about 70% of the overall water consumption is utilized by agriculture sector (Aquastat, 2002).

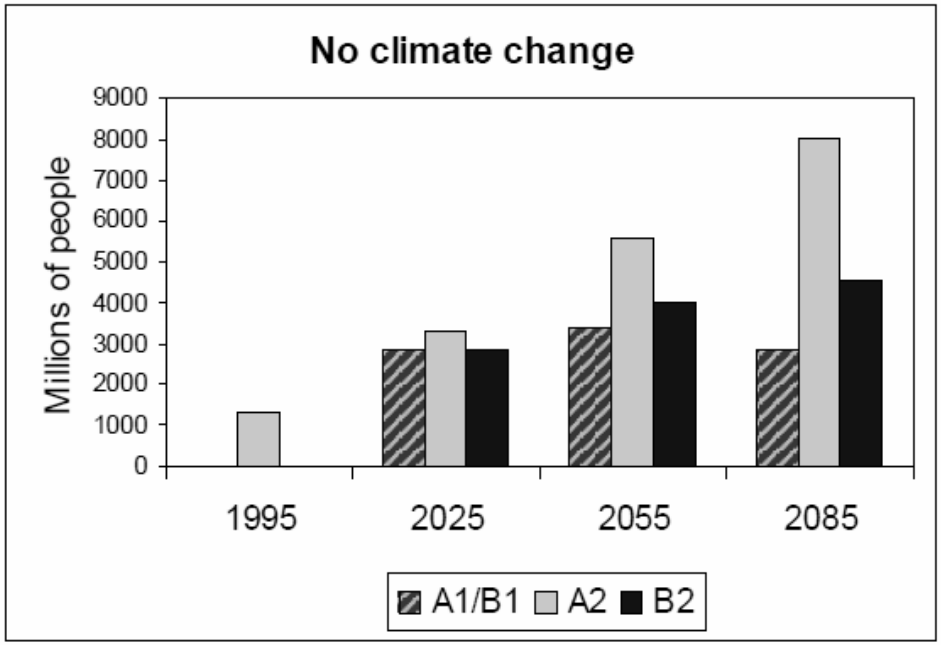
Water consumption in agriculture



Source: FAO 2006.

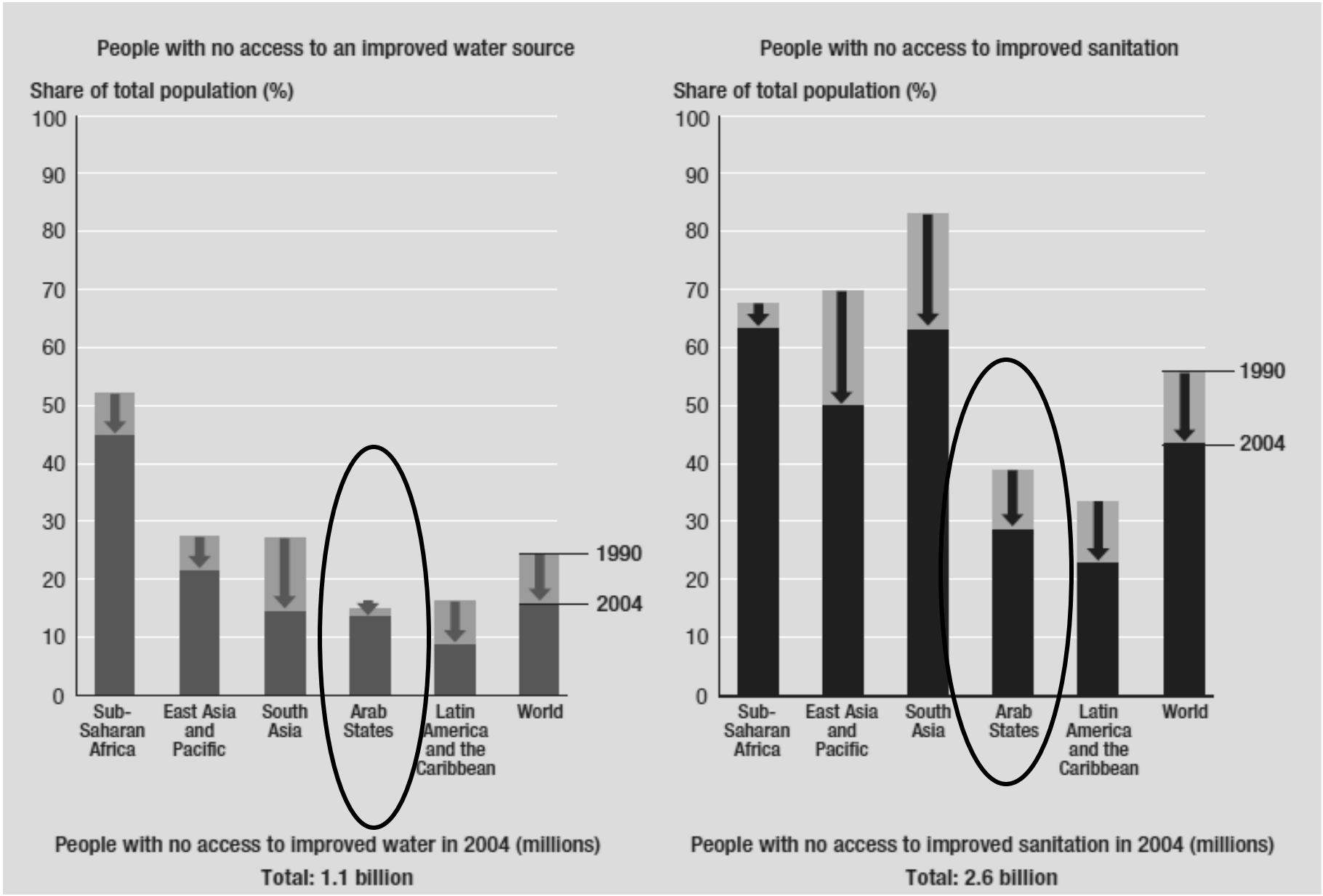
Water vs. Population: non-climate scenarios





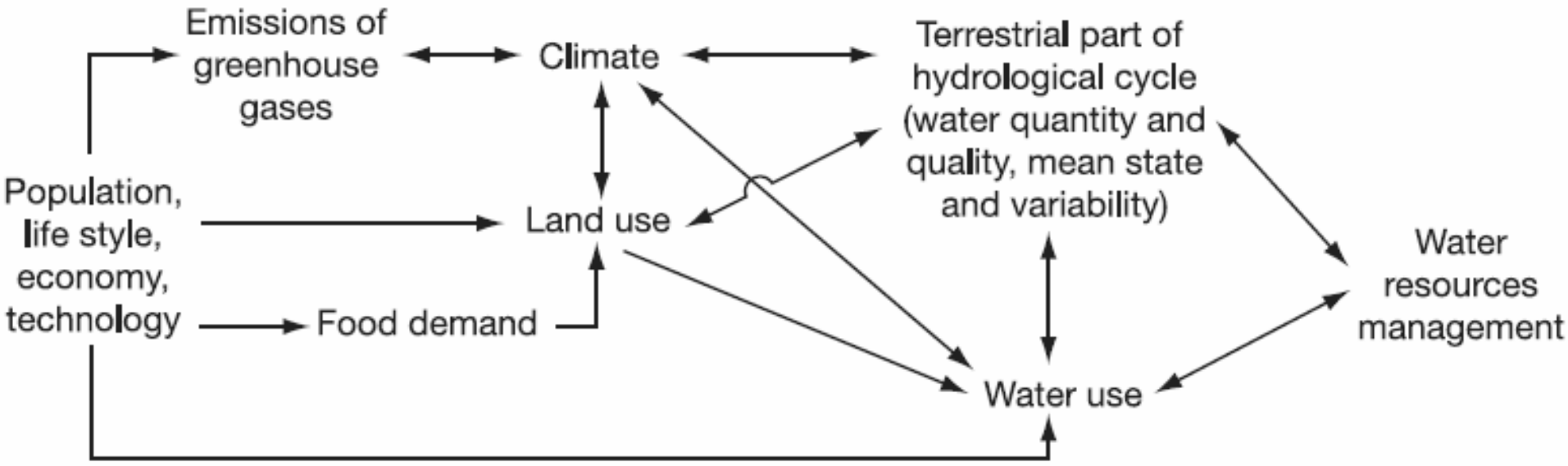
Millions of people living in water-stressed watersheds (< 1000 m3/capita/year)

Water vs. Population: non-climate scenarios



Source: Calculated based on UNICEF 2006a.

Water vs. People



Impact of human activities on freshwater resources and their management, with climate change being only one of multiple pressures (modified after Oki, 2005).

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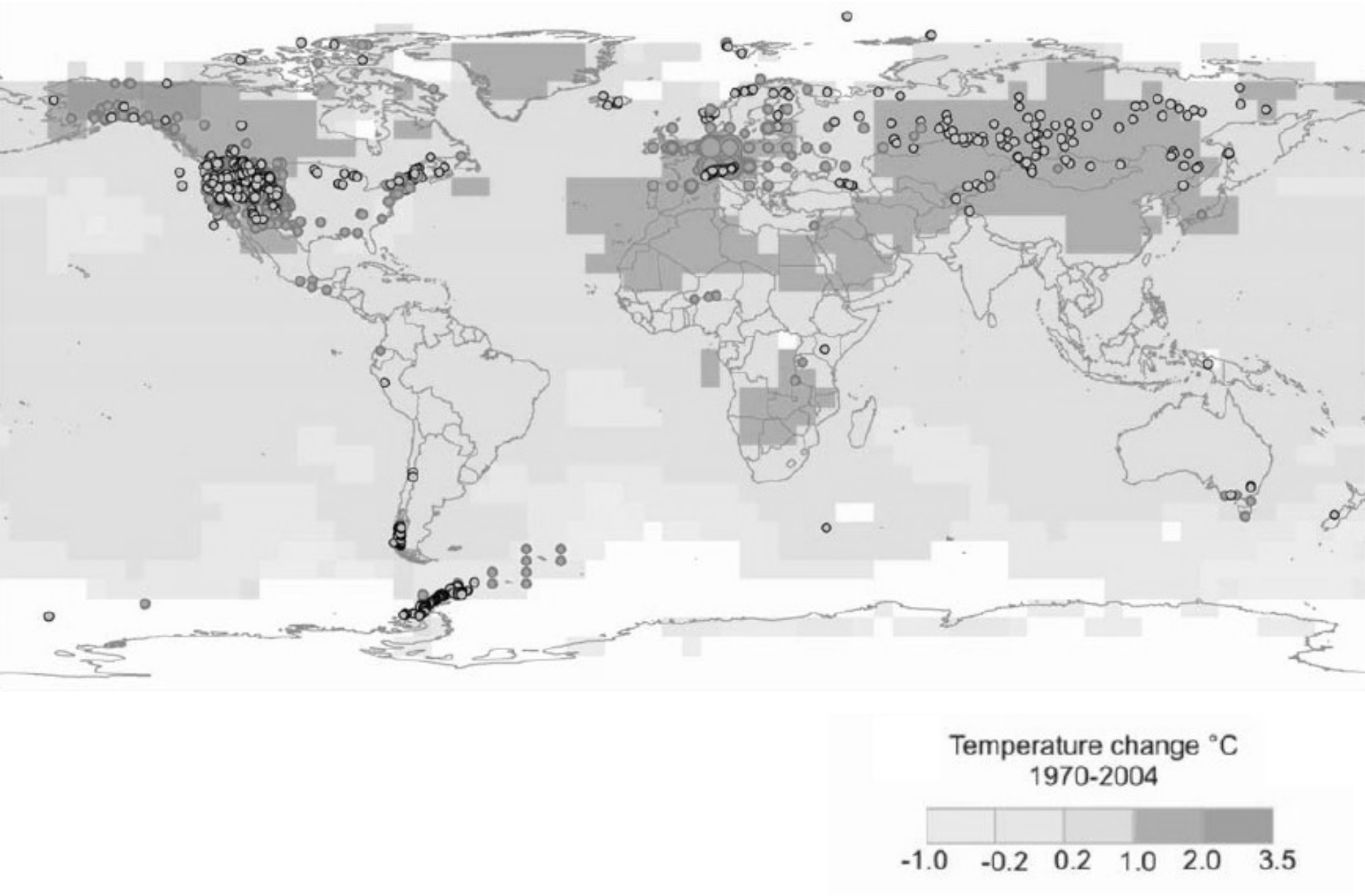
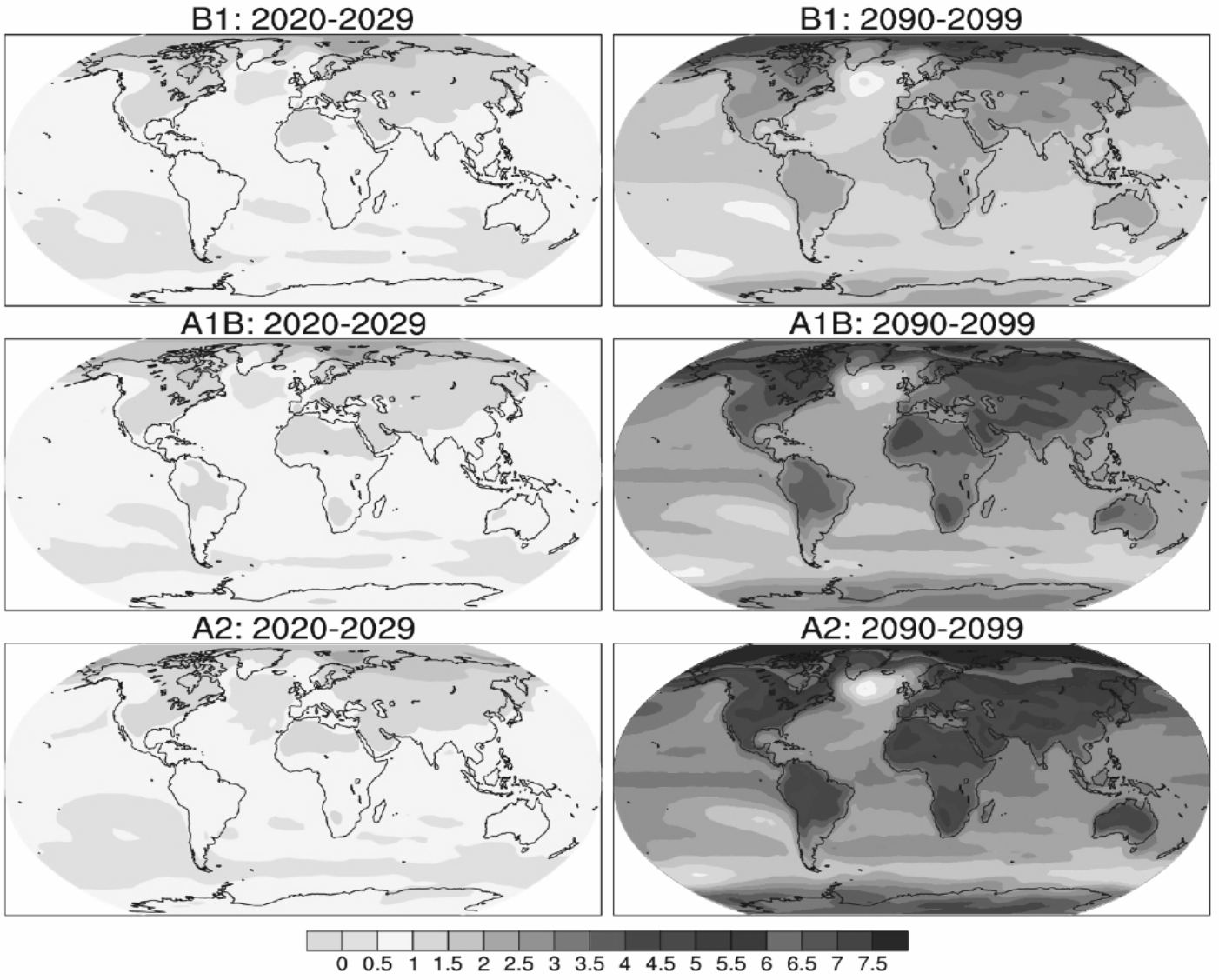
Direct Observations of recent climate change



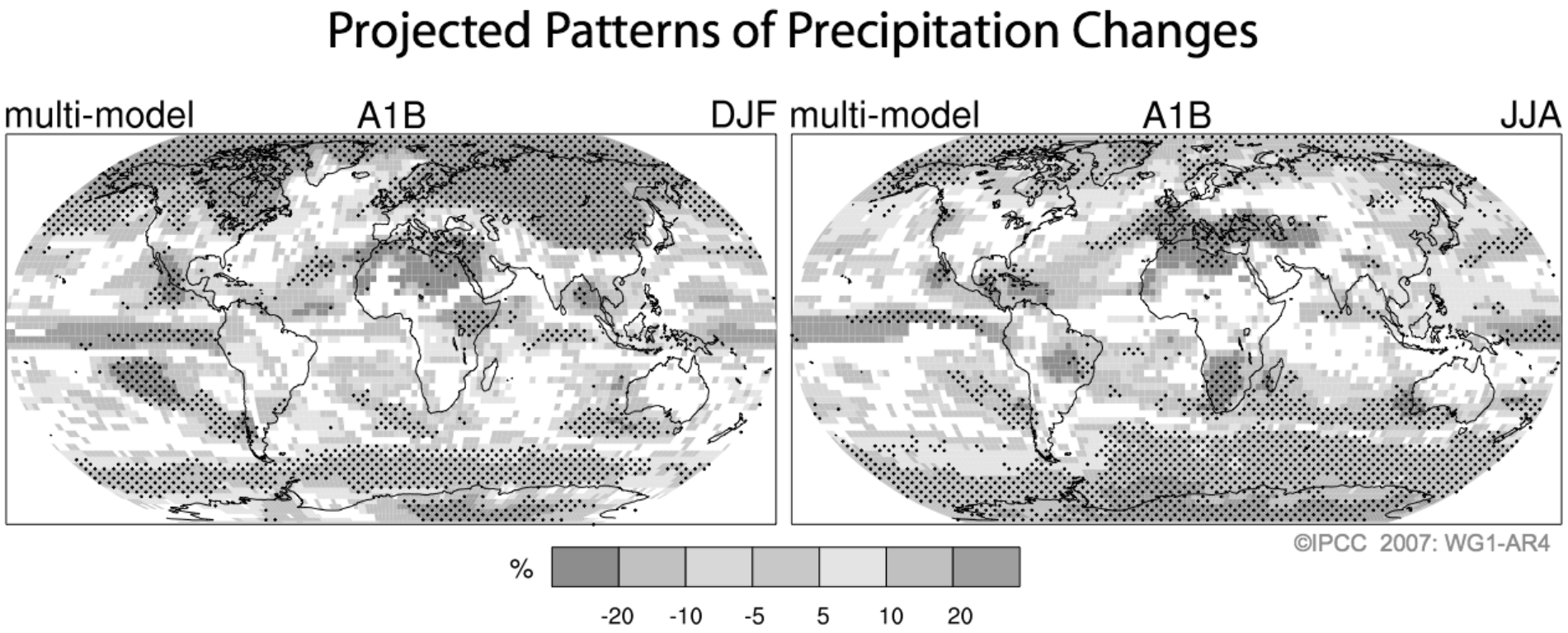
Projections of Future Changes in Climate

Projected warming in 21st century expected to be greatest over land and at most high northern latitudes and least over the Southern Ocean and parts of the North Atlantic Ocean



©IPCC 2007: WG1-AR4

Projections of Future Changes in Climate



Precipitation increases *very likely* in high latitudes

Decreases *likely* in most subtropical land regions

Direct Observations of recent climate change

Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases.

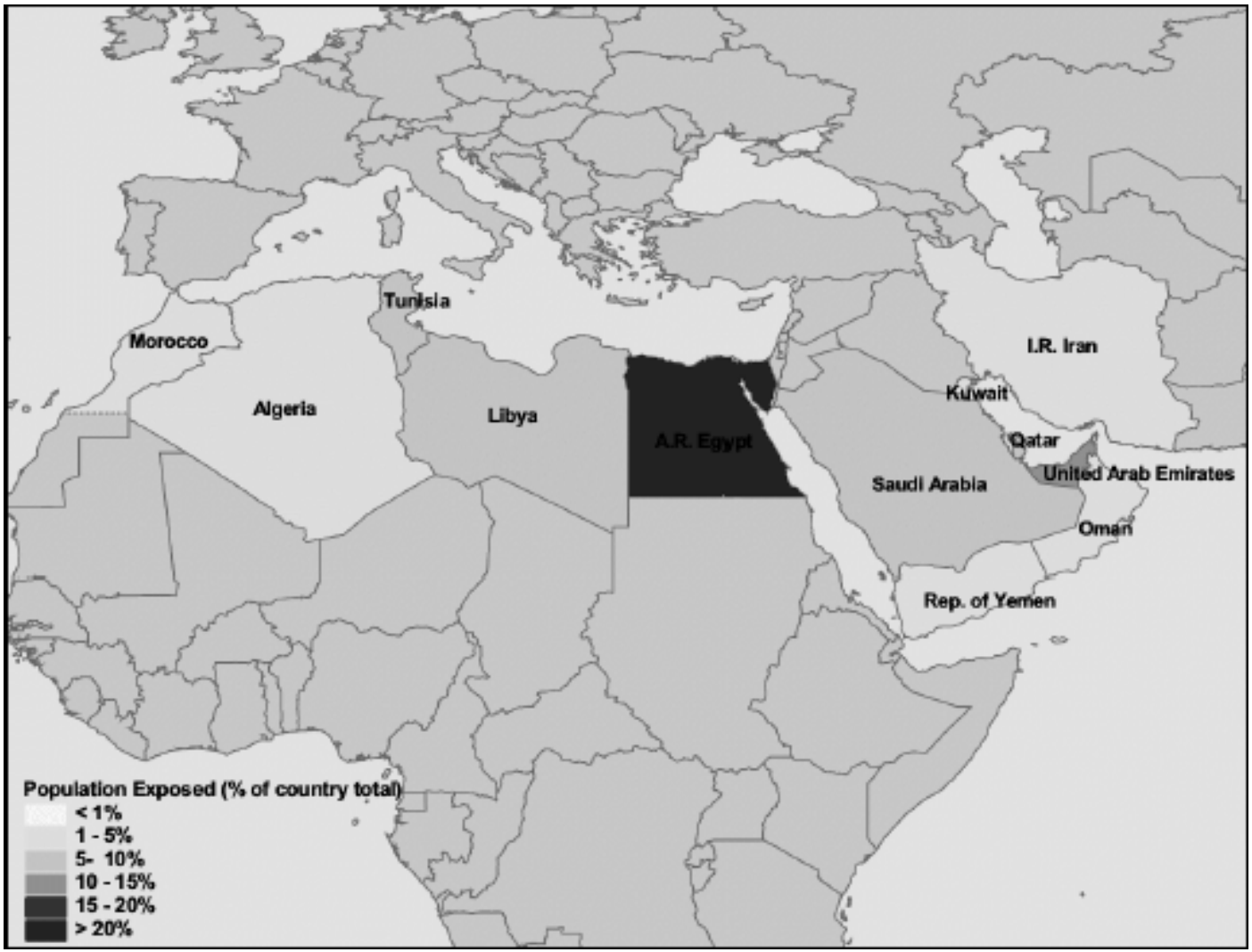
System	Recent Warming Effects (1970-2004)
Snow, ice and frozen ground	•**Enlargement and increased numbers of glacial lakes.** • **Increasing ground instability in permafrost regions.** •Changes in some Arctic and Antarctic ecosystems.
Hydrological systems	•**Increased run-off discharge in many rivers.** •**Changes on thermal structure and water quality of lakes and rivers**
Terrestrial biological systems	•Earlier timing of spring events (bird migration & egg-laying). •Shifts in ranges in plant and animal species. •Earlier 'greening' of vegetation in the spring linked to longer thermal growing seasons.
Oceans	•More acidification with an average decrease in pH of 0.1 units.

The impact of sea-level rise [Middle East case study]

- Global rate of the SLR ,1.8 mm/year [1961 – 2003].
- Projected SLR , 1 to 3m in the 21st century.

	Projected SLR				
	1m	**2m**	**3m**	**4m**	**5m**
country area	**2.6 %**	Qatar			**13.0%**
population,	**10%**	Nile Delta region			**20%**
	5%	U AE &Tunisia			
agricultural extent	**12.5%**	Nile Delta region			**35%**
urban extent	**5%**	Egypt, Libya, UAE, & Tunisia			**10%**
wetlands	Qatar, Kuwait, Libya, & UAE				

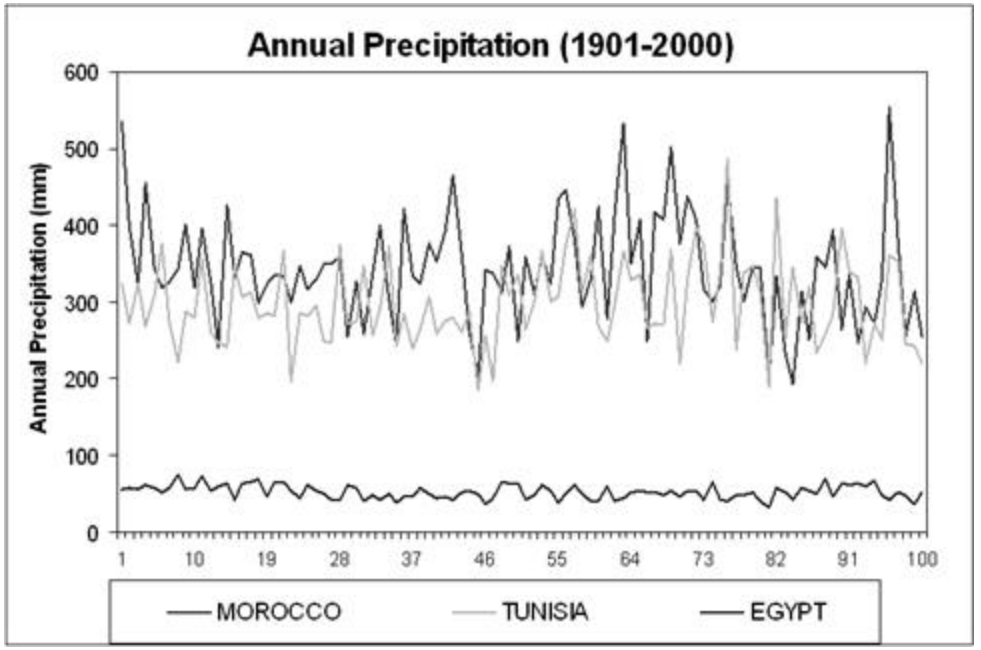
CC impact on sea-level rise in Middle East



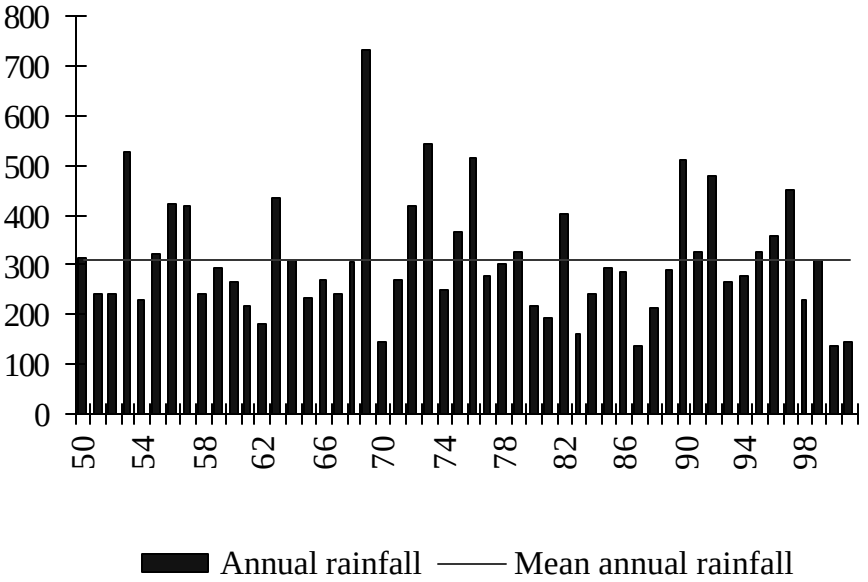
Exposed population to the negative impacts of 5m SLR.
(Dasgupta et al., 2007)

Is there a clear trend of regional precipitation?

Annual rainfall in Egypt, Morocco and Tunisia (1901-2000) aggregated at the country level.

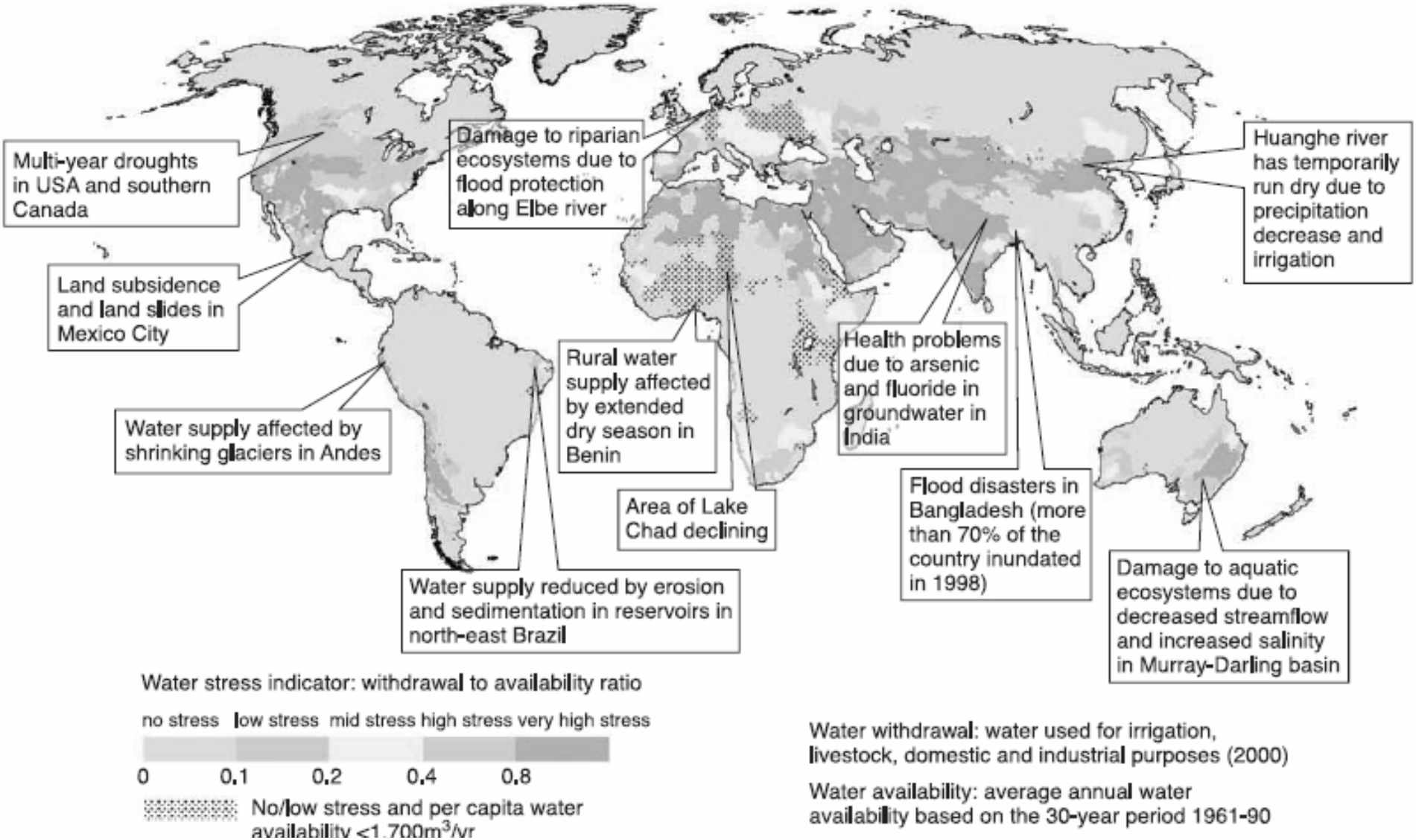


Annual rain distribution in Kairouan, Tunis (1950-2001)

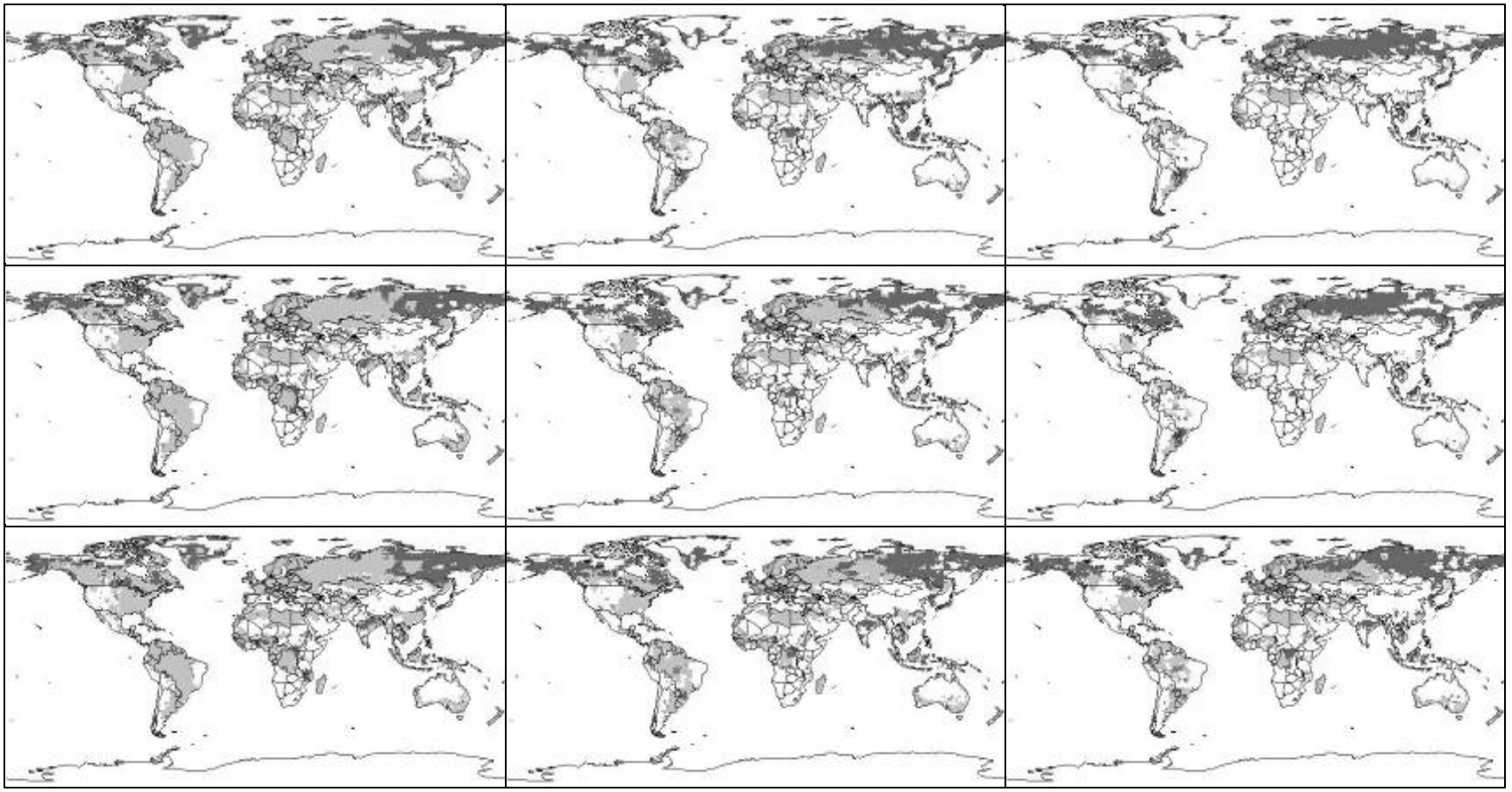


Source: AIACC- AF90 Final Report (2006).

Examples of current vulnerabilities of freshwater resources and their management; in the background, a water stress map based on Alcamo et al. (2003a).



Changes in Available Water Resources



(based on 6 GCM projections under IPCC/AR4)

Blue: significant increase; **Red:** significant decrease;
Grey: no change; **White:** change direction uncertain

CC impacts on water sources (summary)

- Flow of the rivers.
- Salinity and water quality.
- groundwater recharge.
- Balance between the water demand & water supply.
- Water accessibility factors.
- Watershed degradation and desertification.
- Infrastructure & policy and conflicts.

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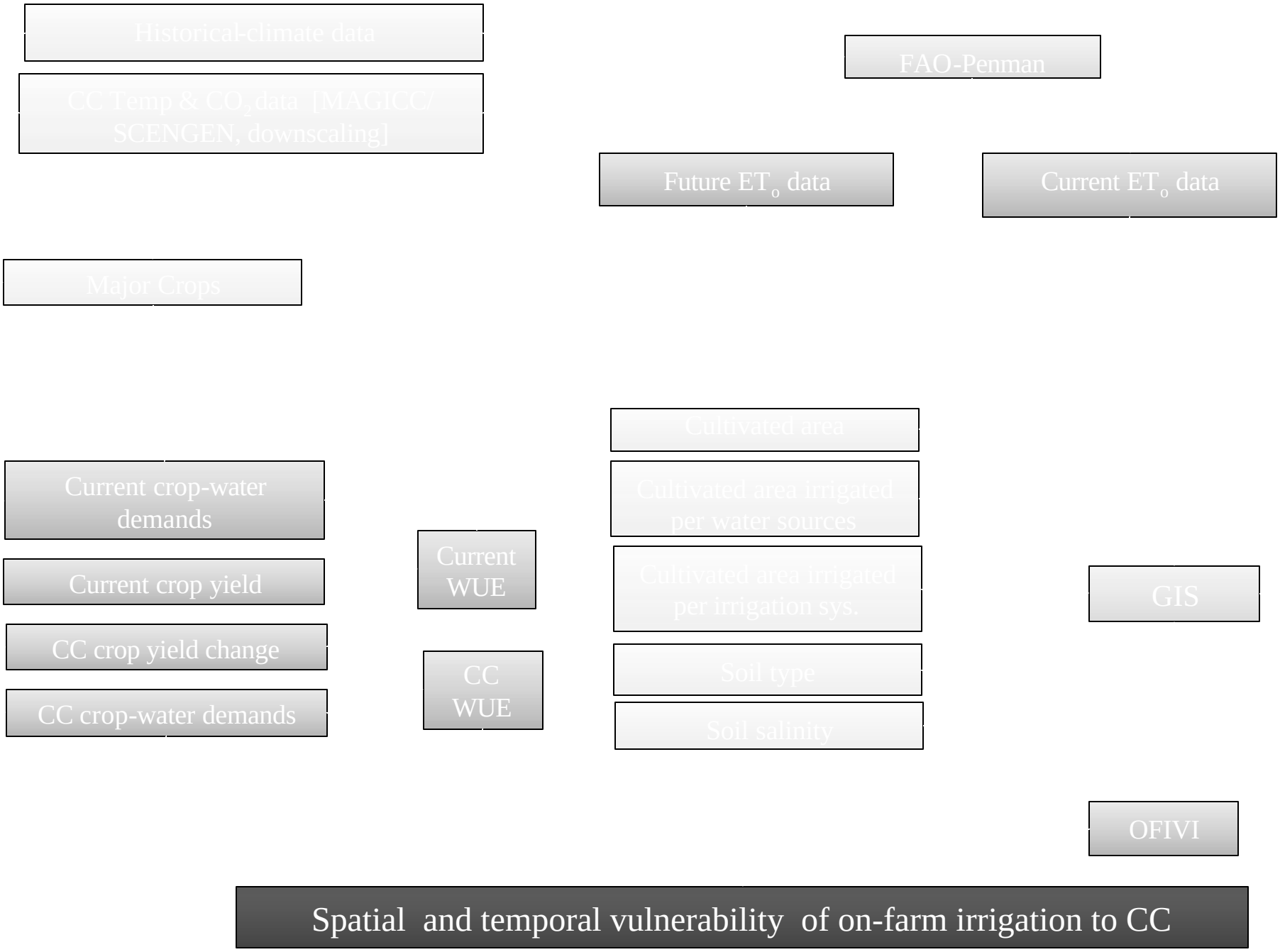
Example:

Multi-criteria vulnerability analysis of on-farm irrigation in Egypt


Historical-climate data
CC Temp & CO_2 data [MAGICC/ SCENGEN, downscaling]
FAO-Penman
Future ET_o data
Current ET_o data
Major Crops
Cultivated area
Current crop-water demands
Cultivated area irrigated per water sources
Current WUE
Current crop yield
Cultivated area irrigated per irrigation sys.
GIS
CC crop yield change
CC WUE
Soil type
CC crop-water demands
Soil salinity
OFIVI
Spatial and temporal vulnerability of on-farm irrigation to CC

Components of vulnerability analysis

- MCA (multi criteria analysis) of vulnerability.
- Community-based assessment
- Representative variables used in the pilot assessment to characterize the vulnerable groups:

components	Proxy variable
1. Natural	1. Climate conditions and observed changes
	2. Soil salinity
	3. Water table
	4. Extreme weather events
	5. Pests & disease
2. Human resources	1. Population density
	2. Agriculture lobar force
	3. Rural population
	4. Knowledge capacity

components	Proxy variable
3. Agriculture management	1. Land ownership
	2. Crop pattern
	3. Corps productivity
	4. Irrigation systems
	5. Irrigation-water use
	6. Fertilizers use
	7. Drainage systems
4. Economic & Policy capacity	1.Finance
	2. Agriculture-production inputs
	3. Agri-products quality
	4. Marketing limitations
	5. Policies conflicts

Medany et al., 2009

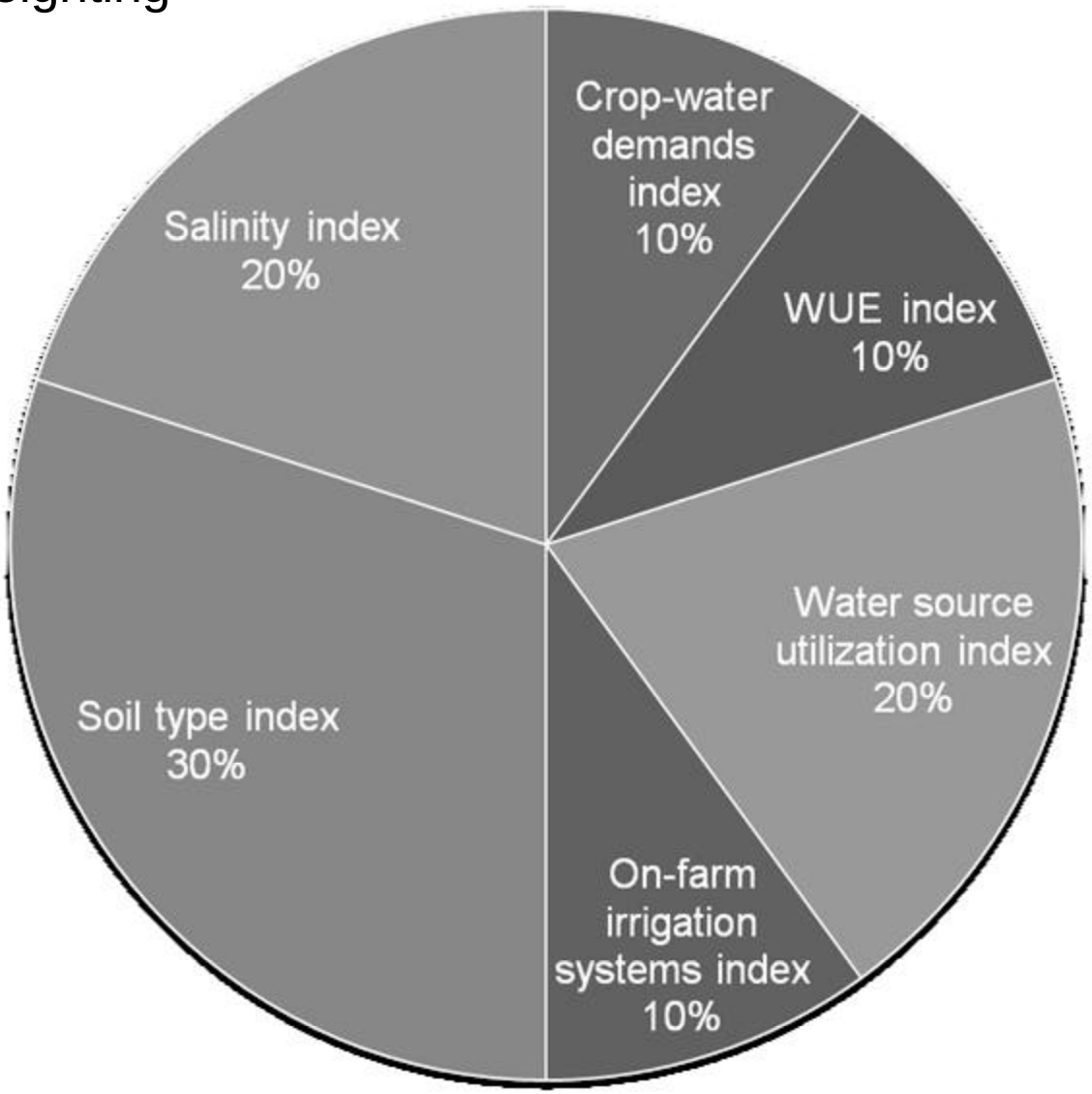
Vulnerability analysis:

OFIVI construction and weighting

- OFIVI is an aggregated dimensionless index ranged from 0 to 1.

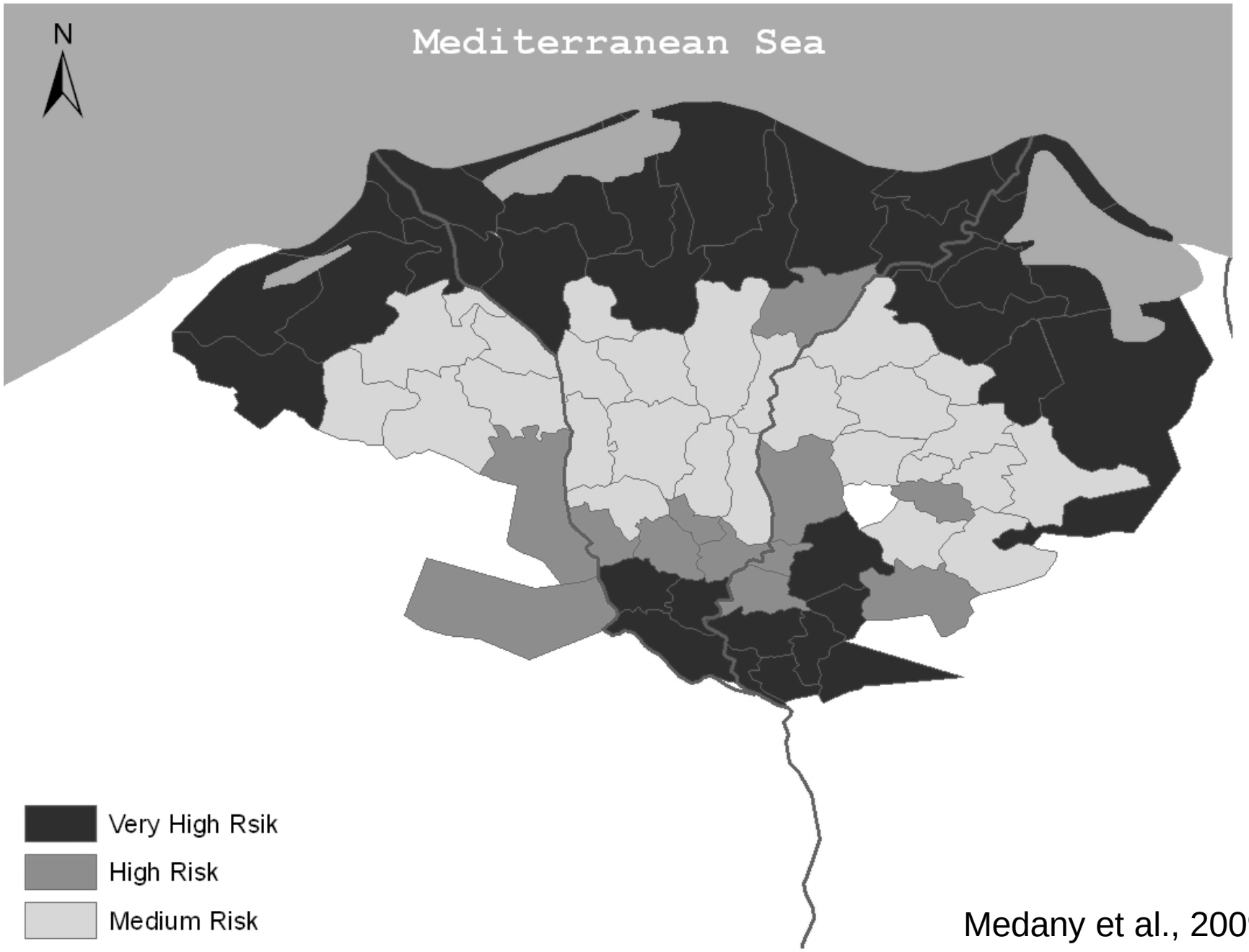
- The index can be applied locally or spatially and with different aggregation levels of the input data.

- OFIVI development methodology based on UNDP methodology of calculating "Human Development Index (HDI)" (UNDP, 2005).



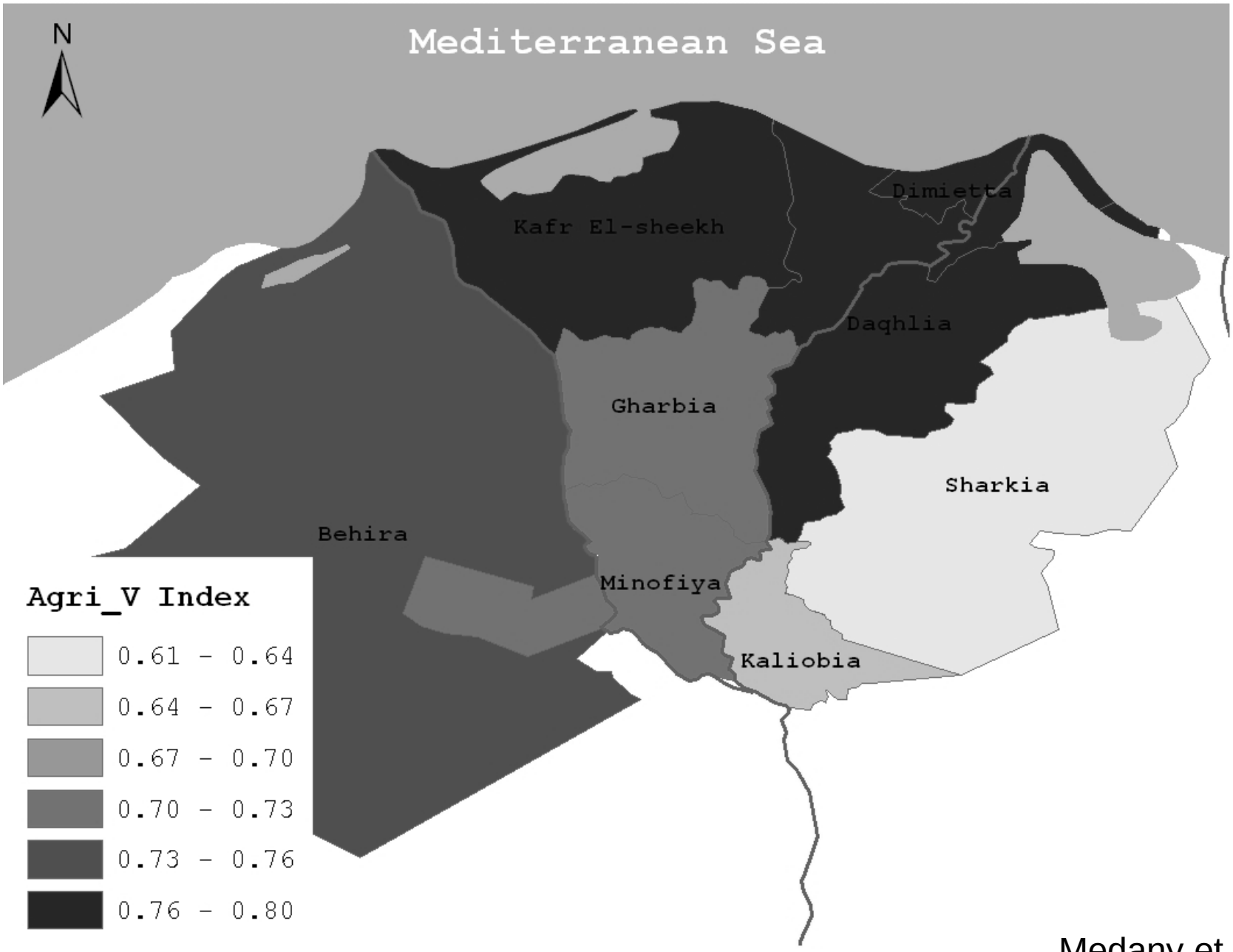
Attaher et al., 2009

Vulnerability Index



Medany et al., 2009

Vulnerability Index



Medany et al., 2009

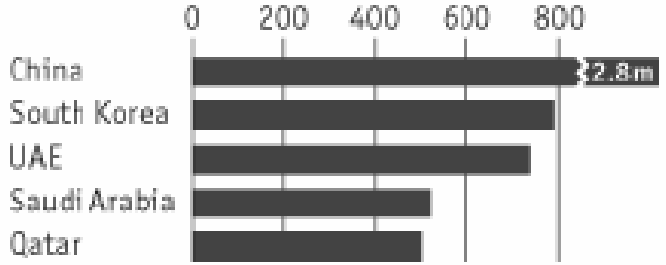
Economist.com

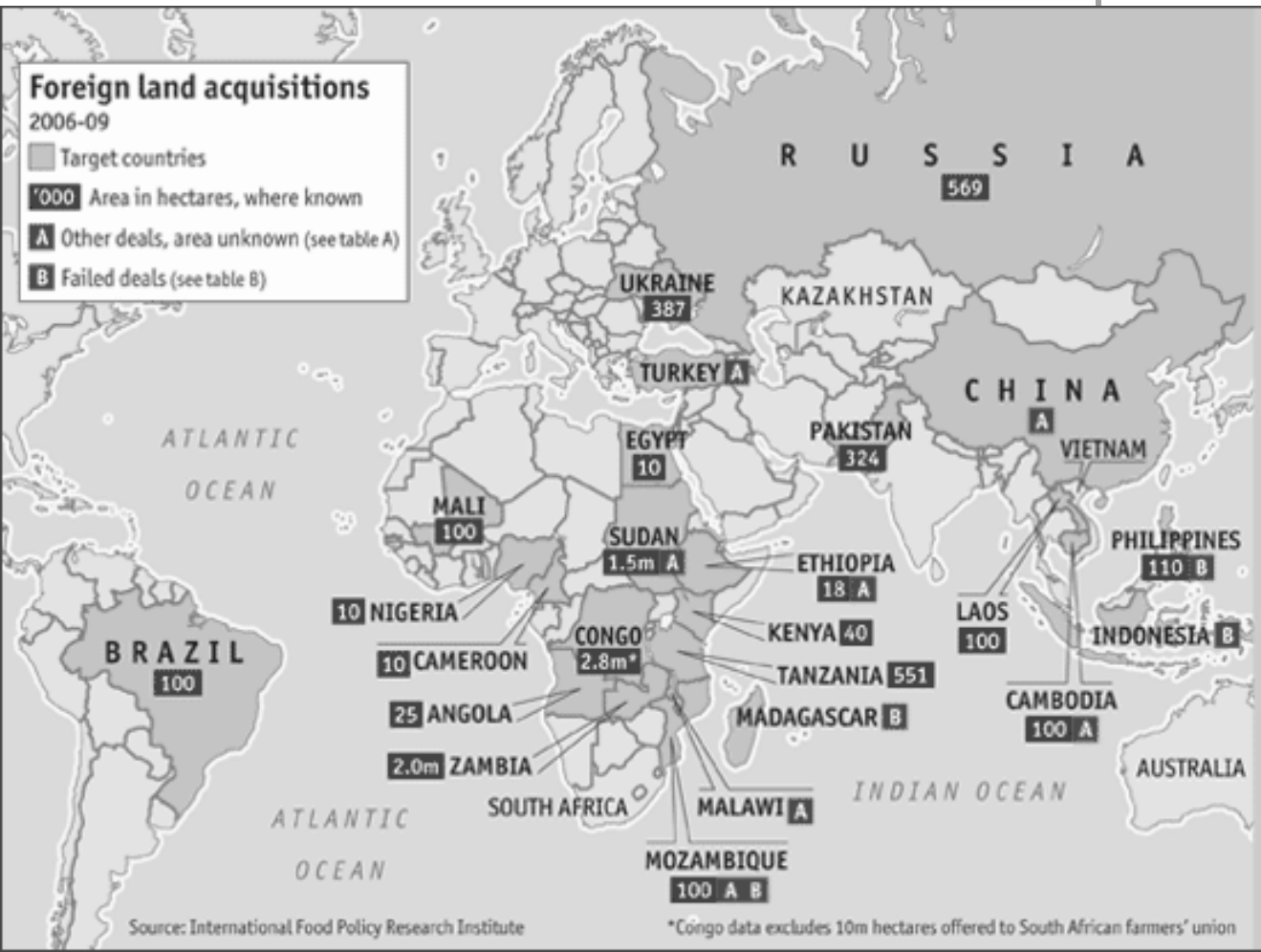
Tuesday June 16th 2009

Food importers are buying agricultural land of poor countries

Farms race

Selected investors, hectares obtained, 2006-09, '000





A: Other deals (area unknown)

Target	Investor	Deal type/value
Cambodia	Kuwait	Land for rice
China	United States *(Goldman Sachs)*	$450m-500m, poultry and pigs
Ethiopia	India	$4bn
	UK *(Sun Biofuels)*	Jatropha
	Saudi investors	$100m
Malawi	Djibouti	unknown
Mozambique	UK *(Sun Biofuels)*	Jatropha
Sudan	Egypt	Wheat (2m tonnes pa)
	Kuwait	"Giant" strategic partnership
	Qatar	Joint holding firm
Turkey	Bahrain *(Agricapital)*	$500m (may rise to $3bn-6bn)

B: Failed deals

Target	Investor	Size of deal
Mozambique	China	$800m
Philippines	China	1.24m ha
Indonesia	Saudi Arabia *(Saudi Binladin Group)*	0.50m ha
Madagascar	South Korea *(Daewoo)*	1.30m ha

Conclusion

•The present water economy and patterns of water use is unsustainable, and it will be most vulnerable under CC.

•Climate change, rapid population growth, and unsustainable water-use patterns will add more stresses on water resources in the Arab region (Arid and semi-arid countries), and increase the vulnerability to water scarcity .

•Policy actions and strategic plans is essential key factors of reducing the impacts of CC over water sector.

Thank you…