COURSE: GEO-INFORMATICS IN EARTH SCIENCE, TECTONIC HAZARD AND INFRASTRUCTURE MANAGEMENT

LECTURE 10 – Science of Drought

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What is Drought

- A drought-stricken displaced persons camp in Konso, Ethiopia. Droughts are becoming increasingly common as global temperatures rise.

Source: Fahmo Mohammed for the IRC, Online: https://www.rescue.org/article/what-drought-causes-impact-countries-most-affected

What is Drought

Severe drought threatens 13 million with hunger in Horn of Africa

- Somali women and children stand outside temporary tents in the Dagahaley refugee camp near the Kenya-Somalia border

Source: UNICEF/Kate Holt, Online: https://news.un.org/en/story/2022/02/1111472

What is Drought

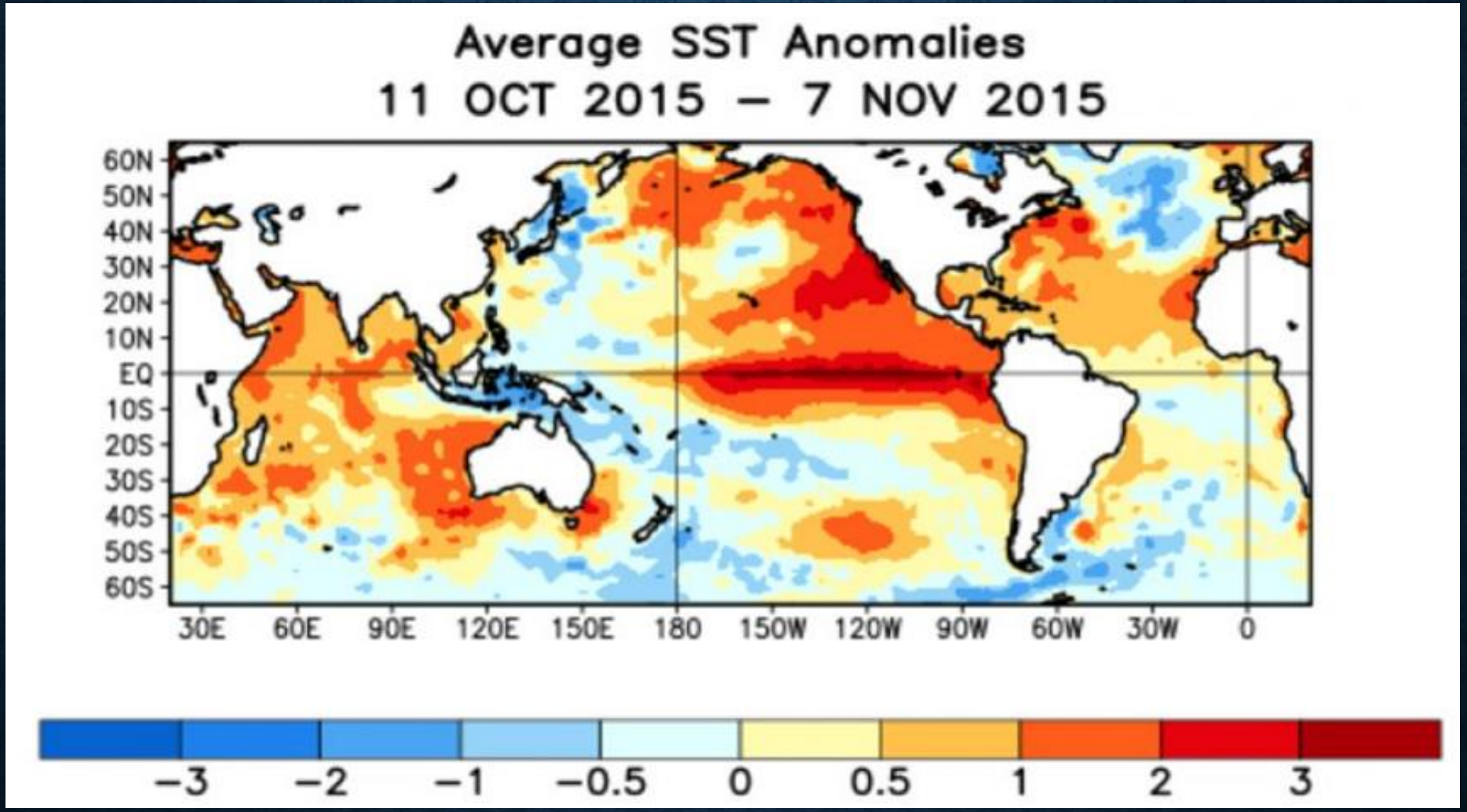
- Ethiopian village during the installation of a drinking water pipeline. Most severe droughts are always experienced in this region.

Source: World Bank, 2019 ; atlantic-kid

What is Drought

- Drought is normally defined as a prolonged period of abnormally dry weather condition leading to a severe shortage of water.
- Drought is a natural temporary feature of the climate cycle that causes damage and can have severe impacts in most regions of the globe.

The causes of drought



Source: NASA, 2015

Sea surface temperature anomaly for the El Nino period for year 2015 to 2016.

What is Drought - Definitions

Vulnerability:

Conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

What is Drought - Definitions

Drought risk

The potential loss of life, injury, or destroyed or damaged assets that could occur to a system, society, or community in a specific period of time, determined probabilistically as a function between drought hazard, exposure, and vulnerability.

What is Drought - Definitions

Drought impact:

Total effect, including negative effects (for example, economic losses) and positive effects (for example, economic gains) of a drought event. The term includes economic, human, and environmental impacts, and may include death, injuries, disease, and other negative effects on human physical, mental, and social well-being.

Types of Drought

The types of droughts commonly identified are;

- meteorological drought,
-
- hydrological drought,

- agricultural drought, and

- socioeconomic drought

Source: World Bank, 2019 ; Wilhite and Glantz 1985.

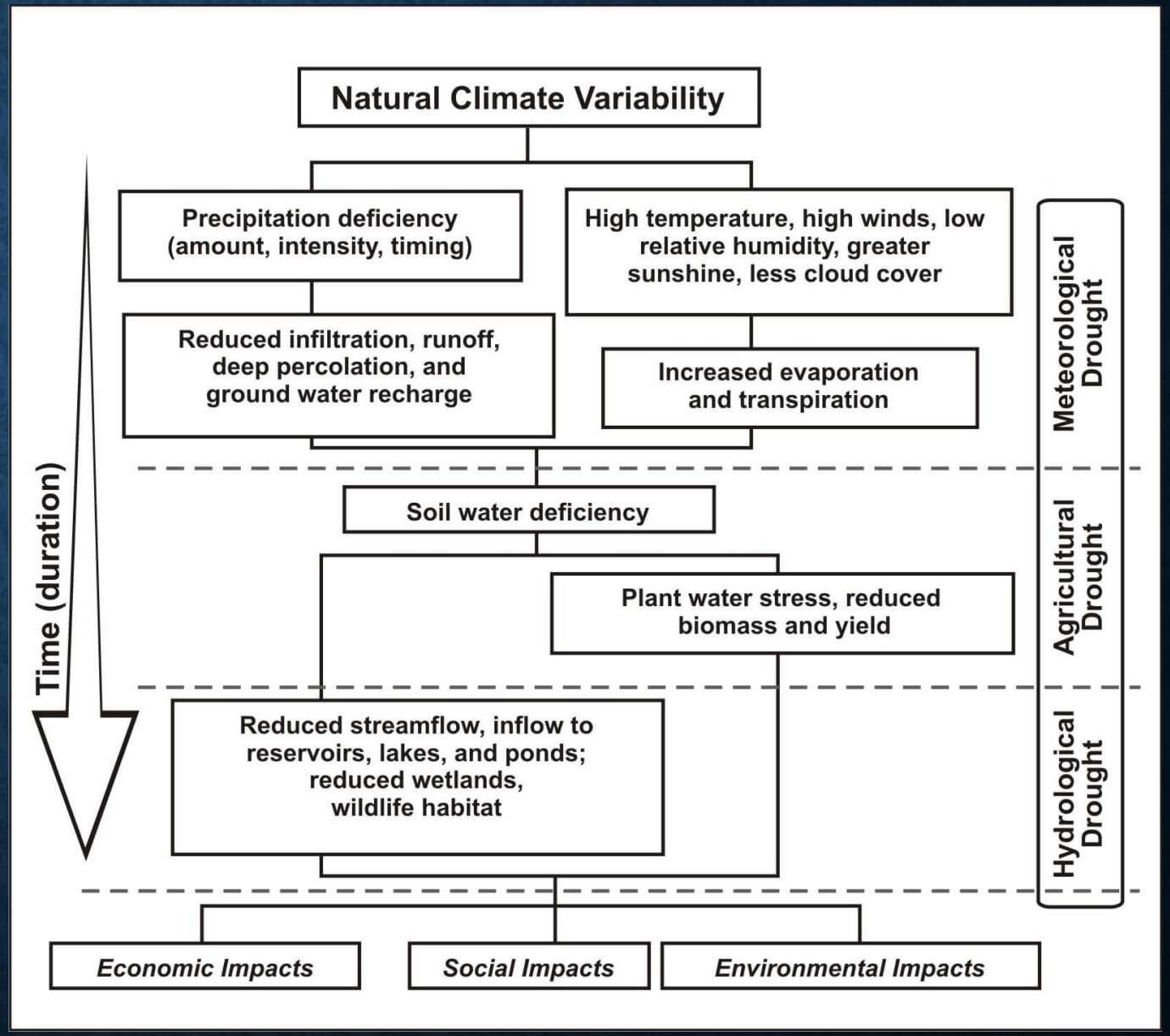
Types of Drought

- The first three of these types of drought are based on physical phenomena, although anthropogenic influence on drought increases as drought propagates from meteorological to hydrological.

- Socioeconomic drought describes droughts in terms of the supply and demand of water.

Types of Drought

Sequence of drought occurrence and impacts for commonly accepted drought types. All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency.



Source: NDMC

Meteorological Drought

- Meteorological drought is usually defined based on the degree of dryness (that is, lack of precipitation) in comparison to some "normal" or average amount of precipitation and the duration of the dry period.

Image Source: CUBANEW/CAN, (2022); Online: http://www.cubanews.acn.cu/cuba/16591-march-third-month-of-meteorological-drought-in-cuba

Hydrological Drought

- Hydrological drought is associated with the effects of periods of precipitation on subsurface water supply, that is;

- ✓ Streamflow/river flow,
- ✓ reservoir and
- ✓ lake levels,
- ✓ groundwater).

- The frequency and severity of hydrological drought is often defined on a watershed or river basin scale.

Image Source: Piyaset/Shutterstock.com; Online: https://www.azolifesciences.com/article/Effects-of-Drought-on-Farming.aspx

Agricultural Drought

- Agricultural drought (sometimes referred to as soil moisture drought) links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, and soil water deficits that can lead to crop failure.

Source: Kud Sitango, NARI, Tambul, Western Highlands, Online: https://dpa.bellschool.anu.edu.au/news-events/news/3262/el-ni%C3%B1o-induced-threats-food-security-papua-new-guinea-png

Source: World Bank, 2019

Socioeconomic Drought

- Socioeconomic drought occurs when the demand of economic goods exceeds supply as a result of a weather-related shortfall in water supply. It is associated with the impacts of meteorological, hydrological, and agricultural droughts on social and economic aspects of the population affected.

Severe drought is killing livestock in the pastoralist community of Higlo Kebele in Ethiopia.

Source: World Bank, 2019

Source: WFP/Michael Tewelde, Online: https://news.un.org/en/story/2022/02/1111472

Drought hazard characterization

Standardized Precipitation Index

- Droughts are often characterized by their severity, duration, timing, and geographical extent.
- To assess the intensity or severity of a drought, the use of different drought indices or indicators for the different types of droughts is accepted as best practice.
- For example, well-known indices for meteorological and hydrological droughts are the Standardized Precipitation Index

Drought hazard characterization

Standardized Precipitation Index

- The Standardized Precipitation Index (SPI) is the most commonly used indicator worldwide for detecting and characterizing meteorological droughts.

- The SPI indicator, measures precipitation anomalies at a given location, based on a comparison of observed total precipitation amounts for an accumulation period of interest (e.g. 1, 3, 12, 48 months), with the long-term historic rainfall record for that period

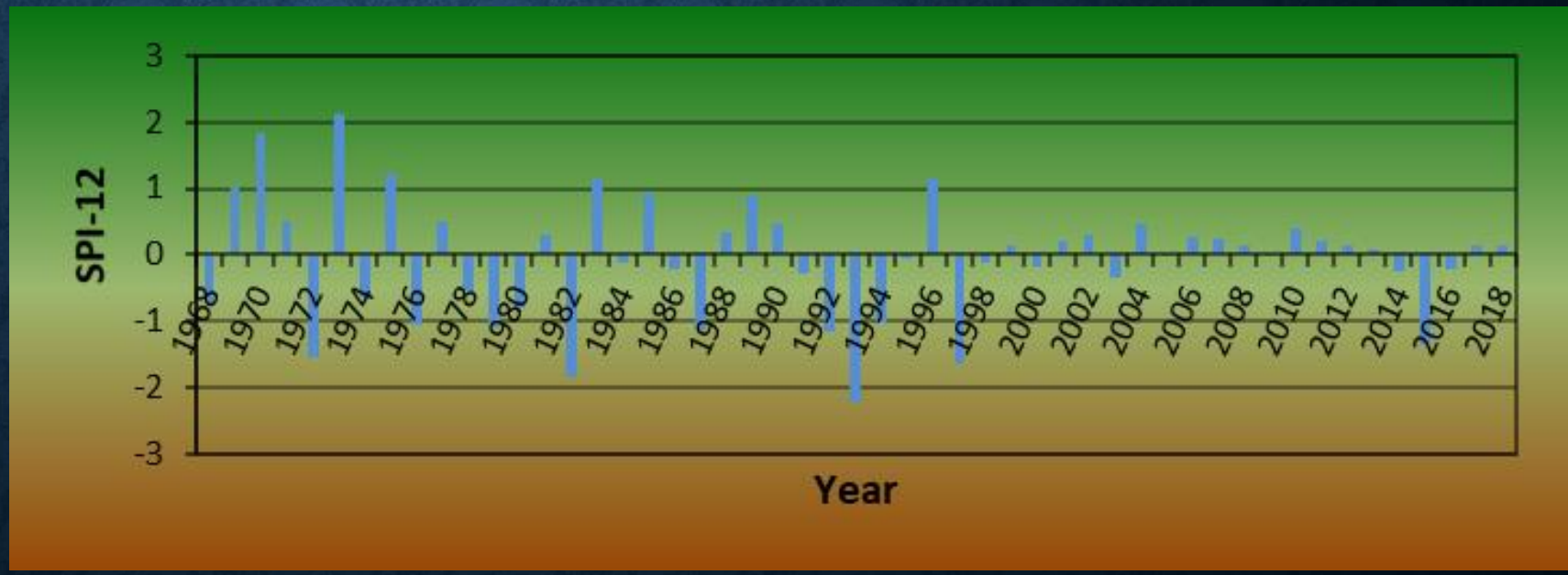
Source: Edwards, D.C. and T.B. McKee. 1997

Drought hazard characterization

Standardized Precipitation Index

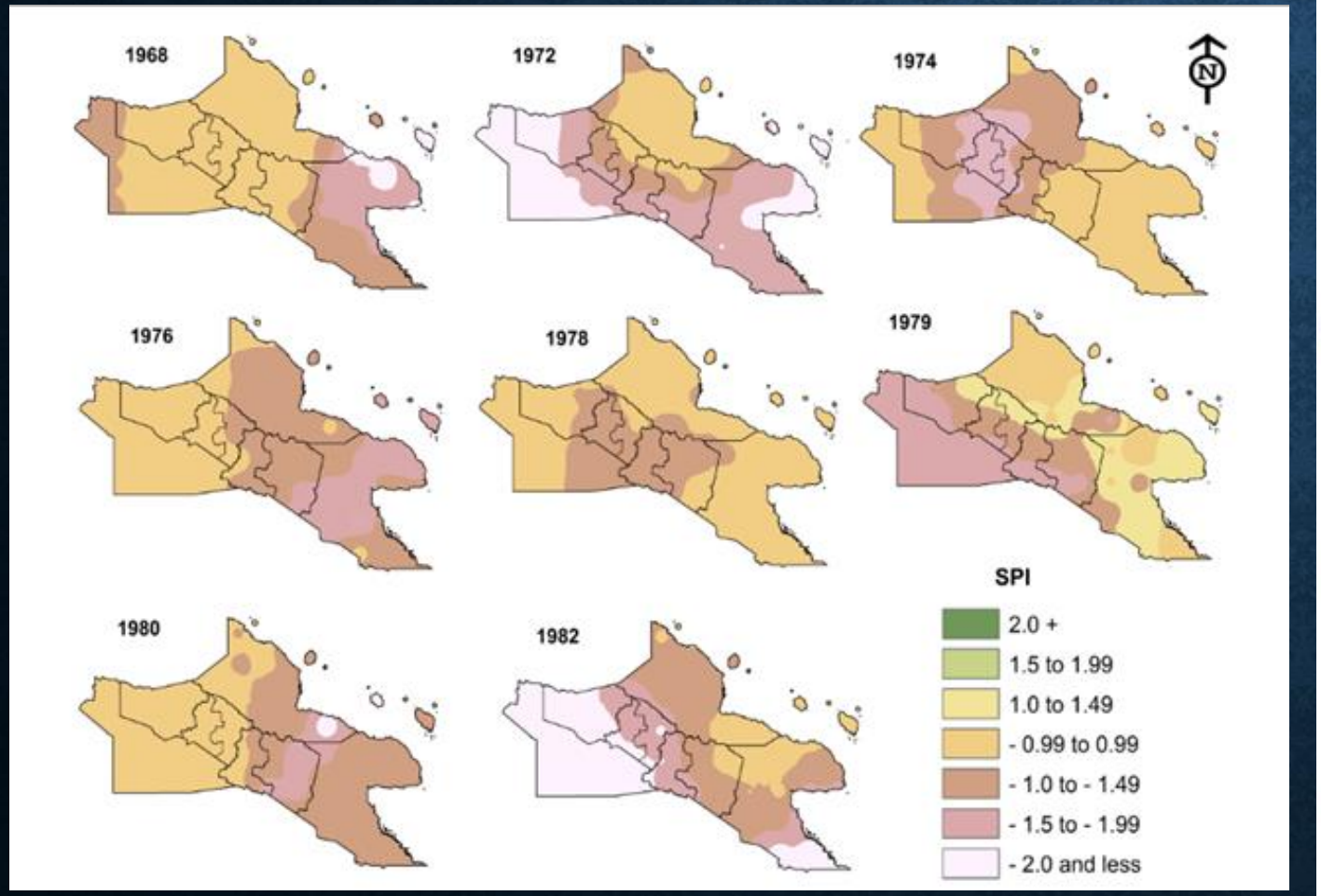
SPI Value Ranges	Category (representations)
+ 2 to more	Extremely wet
1.5 to 1.99	Very wet
1.0 to 1.49	Moderately wet
-0.99 to 0.99	Near Normal
-1.0 to (-1.5)	Moderately dry
-1.5 to (-1.99)	Severely dry
-2 to less	Extremely dry

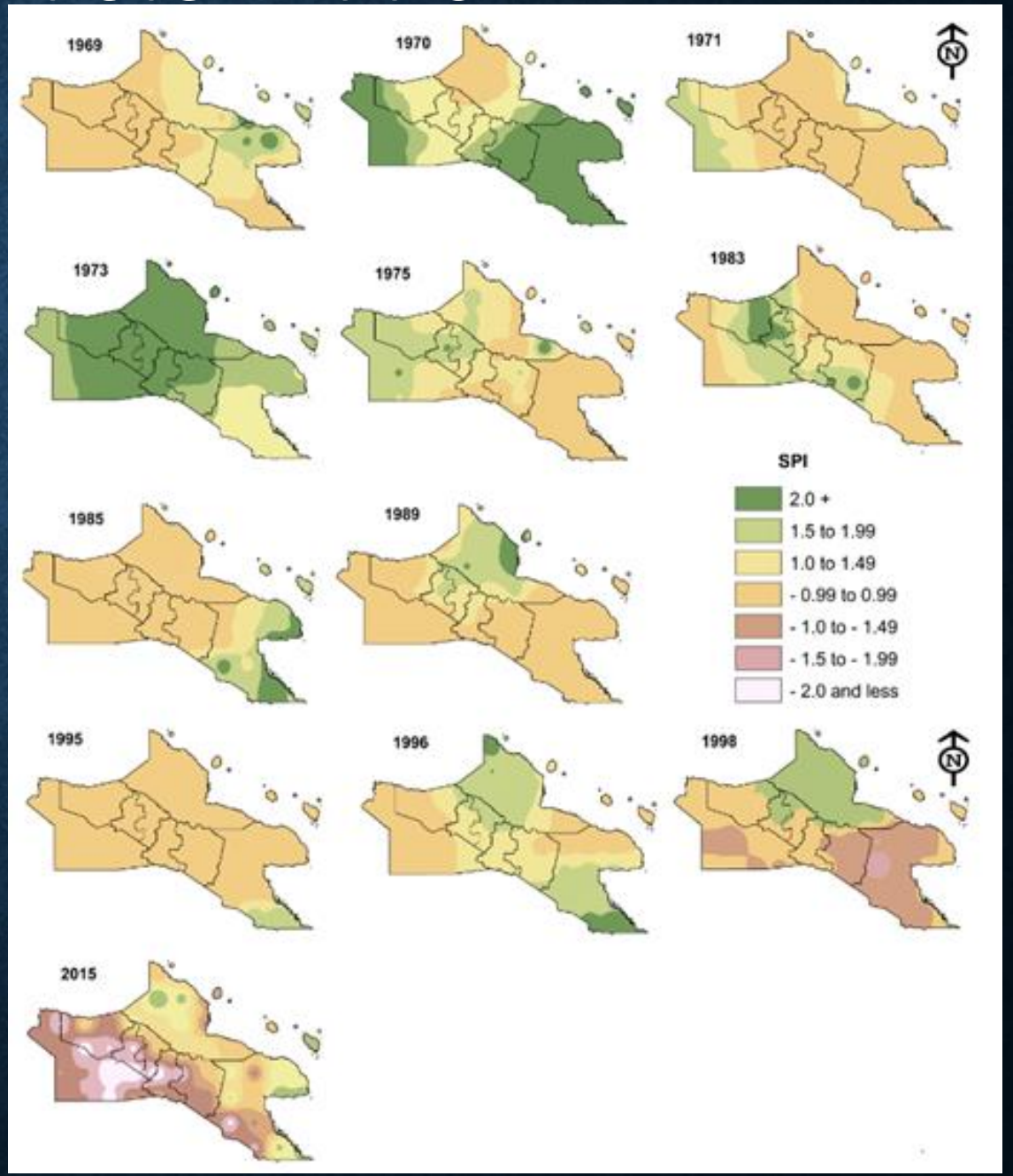
Table Spurce: McKee et al., (1993) and(1995)



Drought hazard characterization

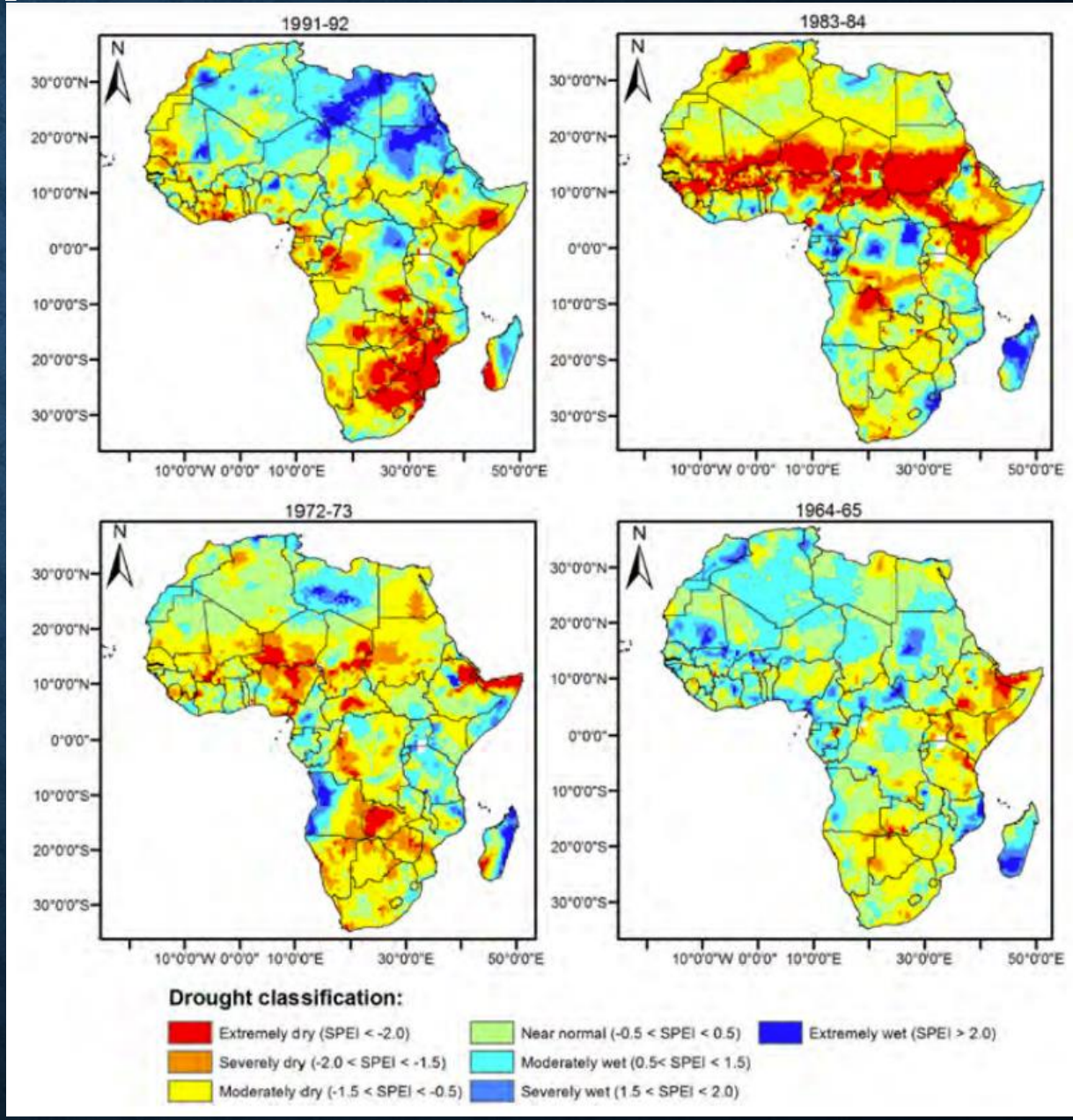
Standardized Precipitation Index





Drought Hazard and Vulnerability Assessment and Mapping

Standardized Precipitation Index



Source: World Bank, 2019., Masih et al. 2014; online: https://www.droughtmanagement.info/literature/WBG_Assessing_drought_hazard_and_risk.pdf

Drought Hazard and Vulnerability Assessment and Mapping

Vegetation Condition Index

- The vegetation condition index (VCI) is an index derived from remotely sensed information.
- It compares the current Normalized Difference Vegetation Index (NDVI) to the range of values observed in the same period in previous years.
- Agricultural drought has most impacts of the drought located in the agriculture sector.

Drought Hazard and Vulnerability Assessment and Mapping

Vegetation Condition Index

Drought grades defined by Vegetation Condition Index (VCI).

Grade Types VCI (%)

1. Normal >50%
2. Drought 35–50%
3. Severe drought <35%

Source: Baniya, B., (2019)

Source: DUTRA et al. (2021)

Drought Hazard and Vulnerability Assessment and Mapping

Exposure to Drought

Exposure to drought comprises all assets and sectors located in a drought-prone area.

Examples of sectors that are susceptible to droughts and are relevant to include as exposure in a drought risk assessment include;

- agriculture,
- energy and industry,
- drinking/domestic water supply,
- navigation,
- ecosystems,
- tourism,
- forestry,
- aquaculture and fisheries, and the
- financial sector (investors, insurances, asset owners).

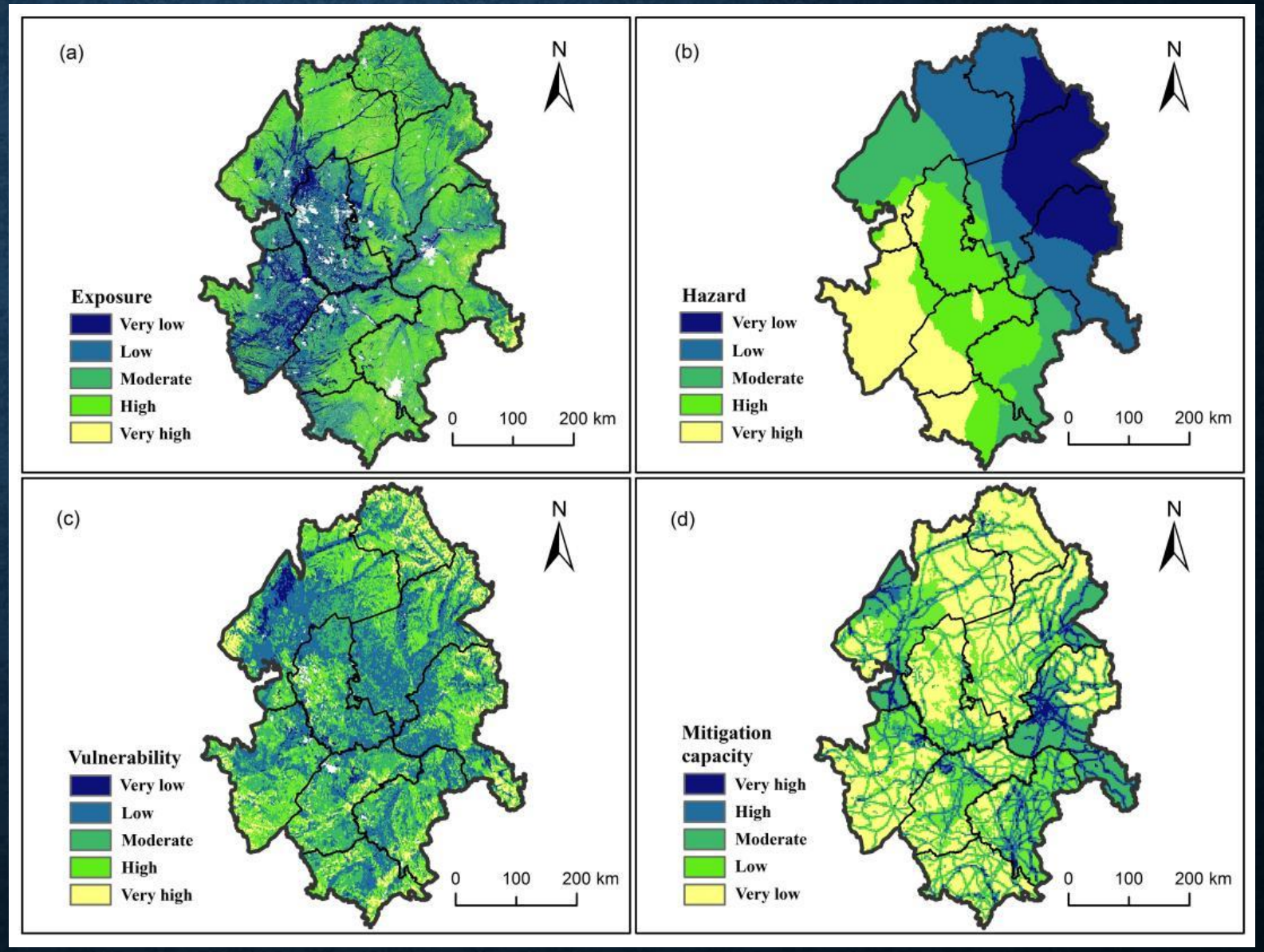
Drought Hazard and Vulnerability Assessment and Mapping

Exposure to Drought - Agriculture

Variables that can be used to measure and/or express drought exposure for the agriculture sector are, among others:

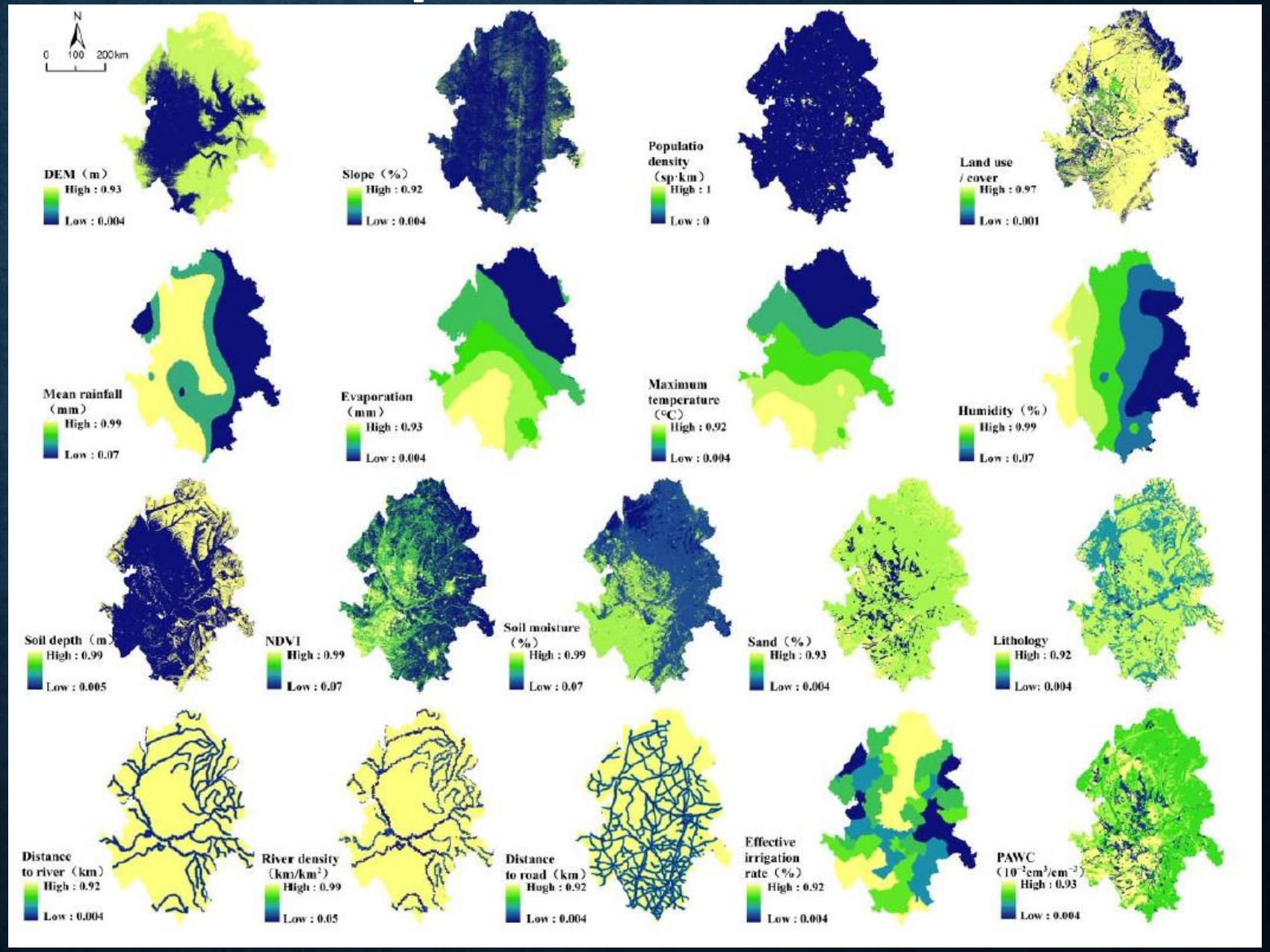
- Agricultural land area
- Agricultural crop types
- Potential agricultural yield in volume or monetary value
- Livestock (for example, cattle, pigs, and poultry) density

Drought Hazard and Vulnerability Assessment and Mapping



Source: Gao, F. et al, (2023)

Drought Hazard and Vulnerability Assessment and Mapping



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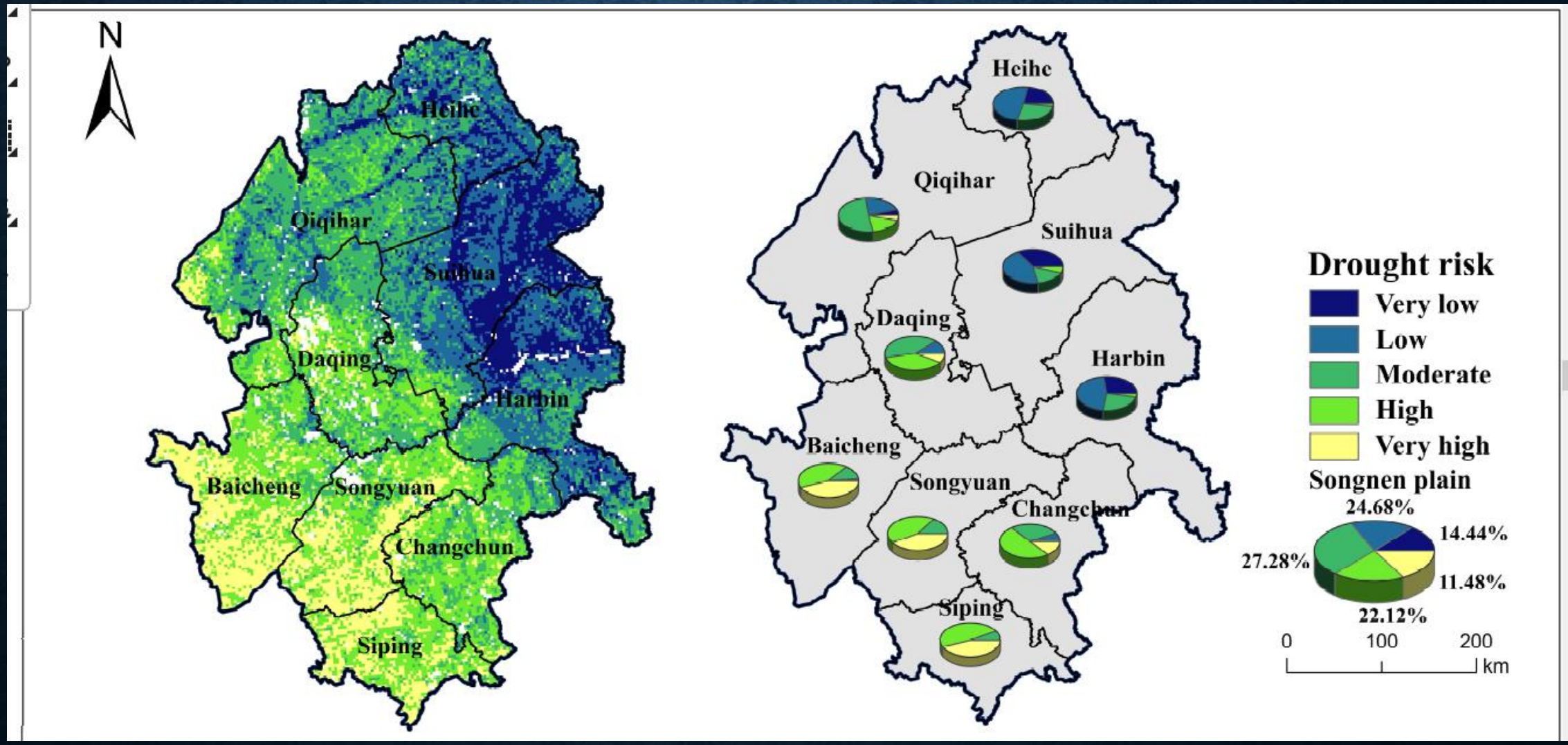
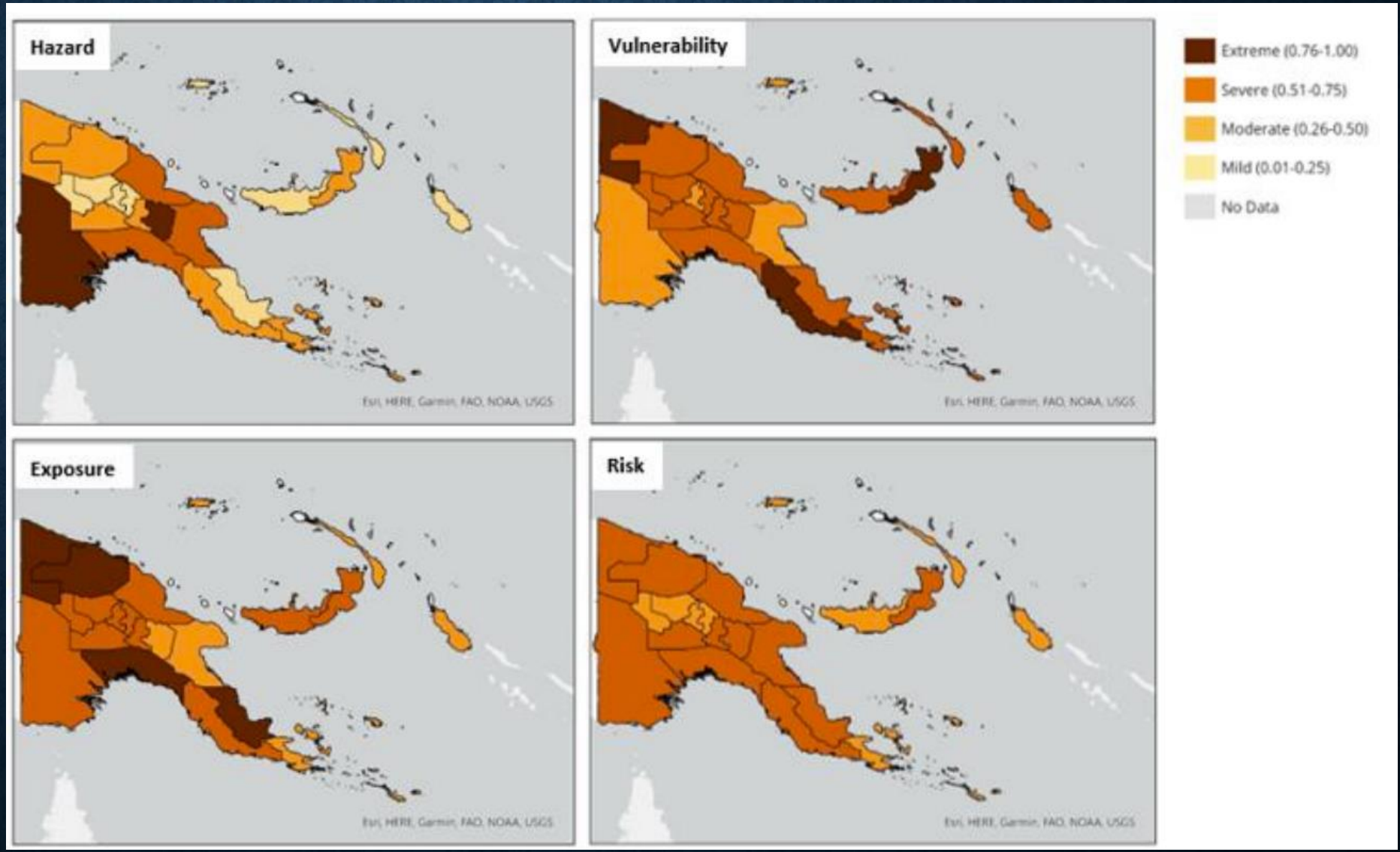
Drought Hazard and Vulnerability Assessment and Mapping



Source: Gao, F. et al, (2023)

Drought Hazard and Vulnerability Assessment and Mapping

Overall drought risk maps of PNG provinces for 2014 including a drought hazard, drought vulnerability, drought exposure and drought risk map detailing the index level of each province



Source: Aitkenhead, I. et al., (2023). Online: https://nhess.copernicus.org/preprints/nhess-2021-278/nhess-2021-278.pdf

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