Groundwater-dependent ecosystems (GDEs) in China: Where they are and how they vary

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Groundwater Dependent Ecosystems （GDEs）

The definition is if groundwater changes beyond its "normal" range of fluctuation, the ecosystem will be significantly altered or even degraded (Colvin et al., 2003). GDEs may rely on groundwater fully or partially, permanently or for a short time period.

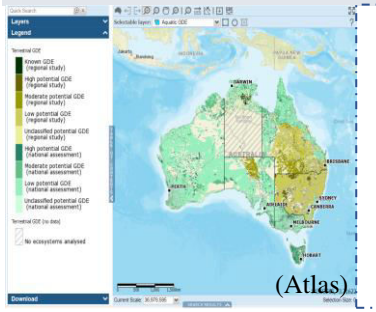
Classification according to type of aquifer
(Eamus et al., 2006)

- Aquifer and cave ecosystems
- **All ecosystems dependent on the surface expression of groundwater**
- **All ecosystems dependent on the subsurface presence of groundwater**

Groundwater Dependent Ecosystems （GDEs）

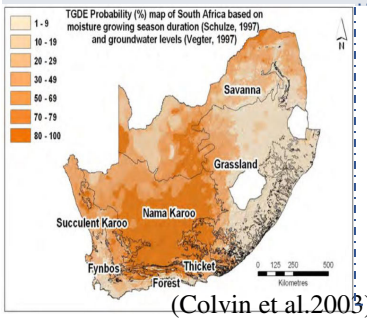
➢ In some countries, GDEs have been protected under law. For example, in Australia, management of GDEs began in 2004. In National Water initiative, a certain amount of water must be allocated to GDEs.

Australia


(Atlas)

- Management began in 2004
- National Water Initiative
- Easy for government to manage

South Africa



(Colvin et al.2003)

- Water Act 1998
- Defined as terrestrial ecosystems

America

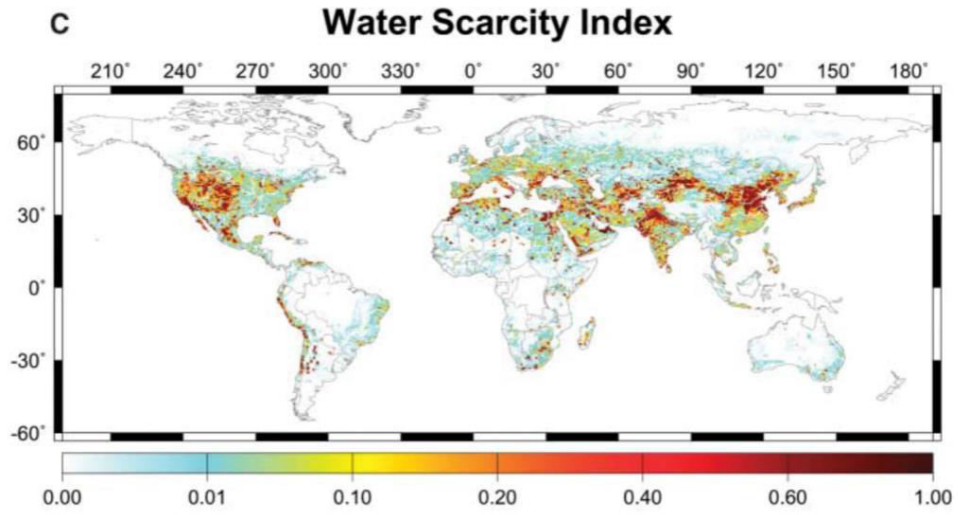
- Mainly California
- Sustainable Groundwater Management Act passed in 2014

Europe

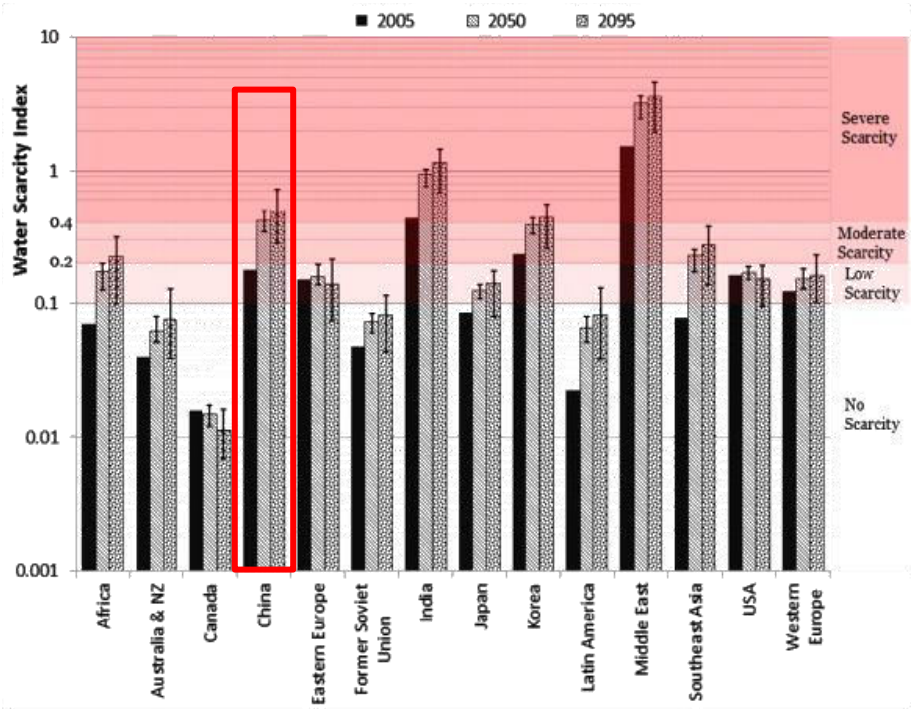
- Water Framework Directive 2000
- Has the force of law
- Portugal, Poland, etc.

Why to map GDEs

- Besides supporting GDEs, groundwater is also the largest stock of freshwater in the world available for human development. The excessive pumping of groundwater is threatening GDEs. Therefore, information on the location of GDEs is critical.



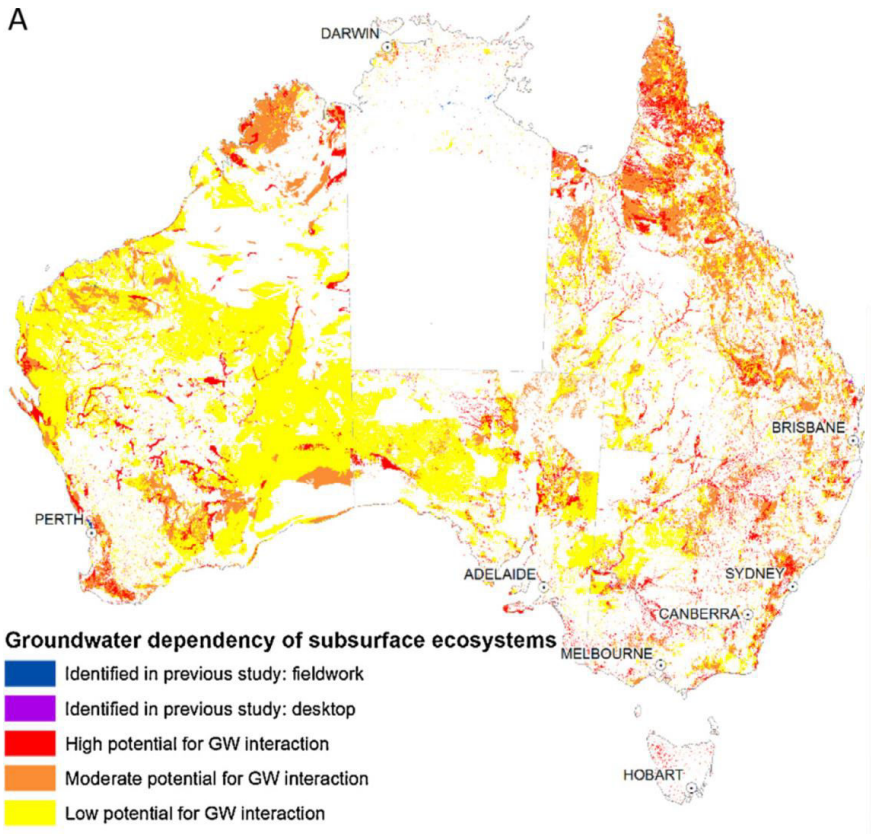
(Oki et al. 2006)



(Hejazi et al. 2014)

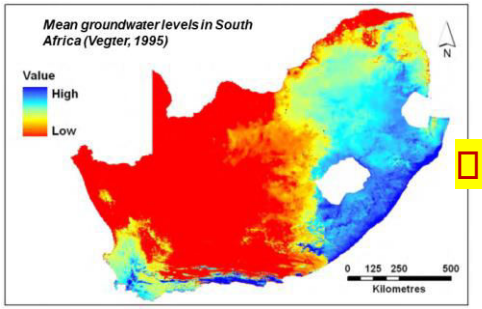
Case studies at country level

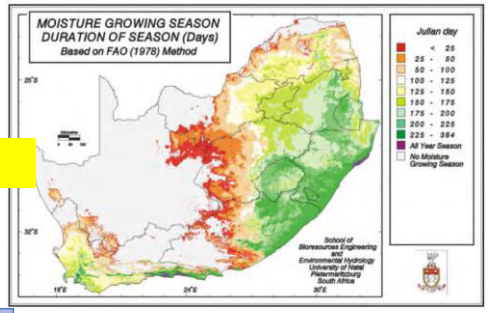
Australia

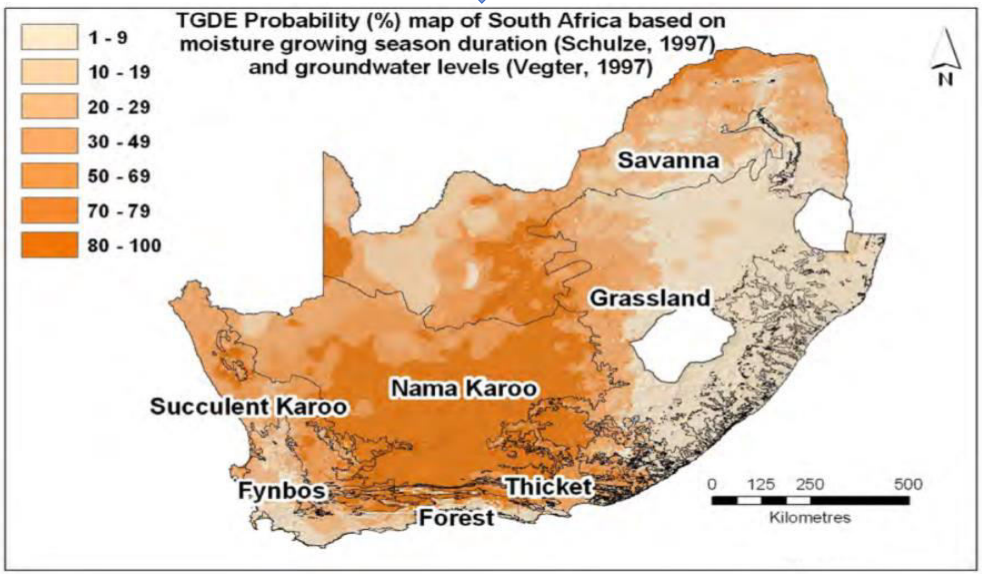


(Doody et al.2017)

South Africa







(Colvin et al.2003)

Currently, GDEs mapping is mainly conducted at catchment level. To my knowledge, at country level, only Australia and South Africa, mapping covers the entire nation.

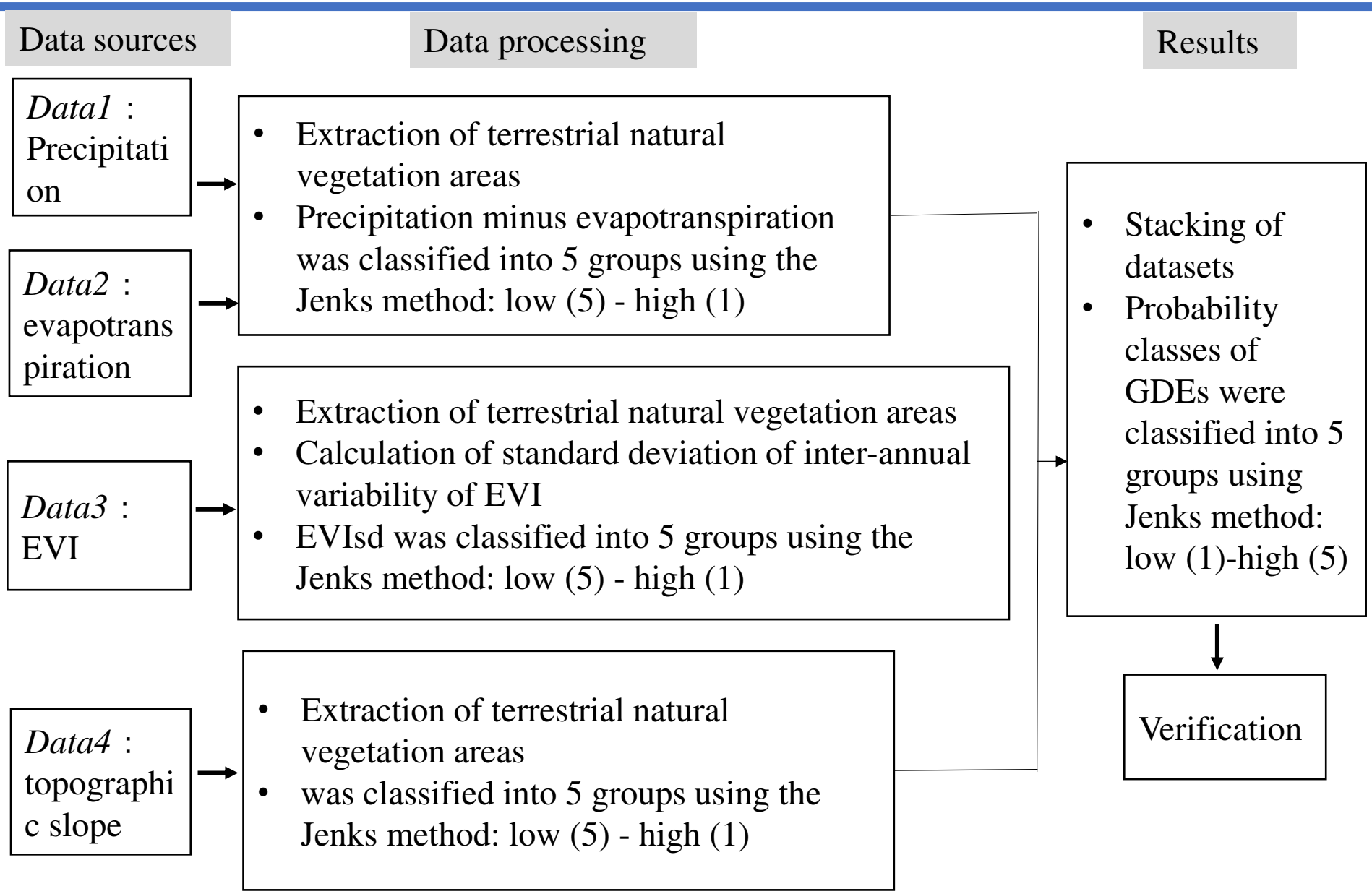
Methodology

Ecosystem mapping are based on

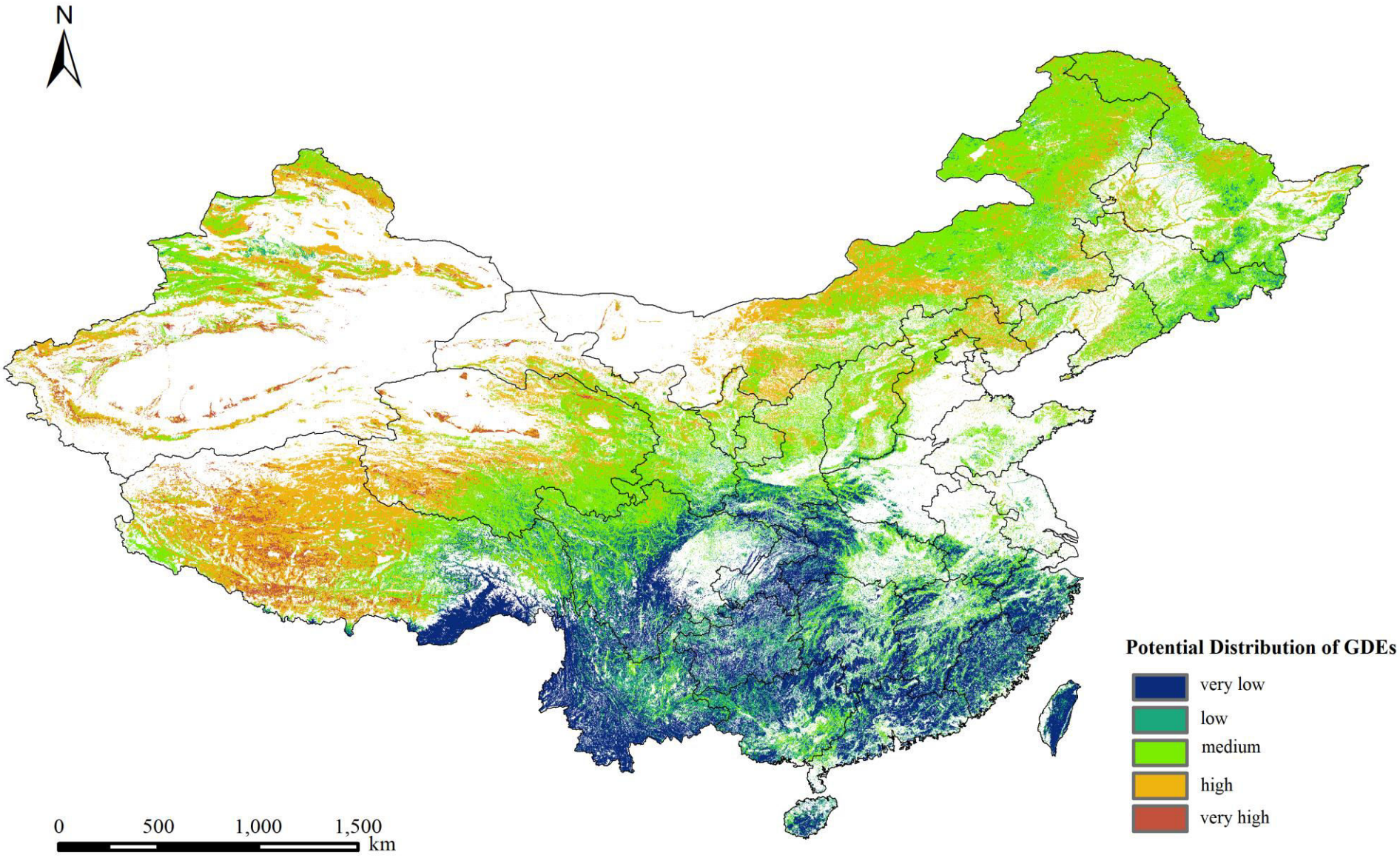
- field survey data collection
- Remote sensing
- Integration of remotely sensing data and ground-based observations using GIS technology

How to map GDEs? Among the methods being capable of detecting GDEs, field survey methods are useful at small areas, and require a great deal of time, manpower and materials. RS in combination with GIS is the most applicable one for large-scale mapping owing to its cost efficiency, broader coverage and data availability.

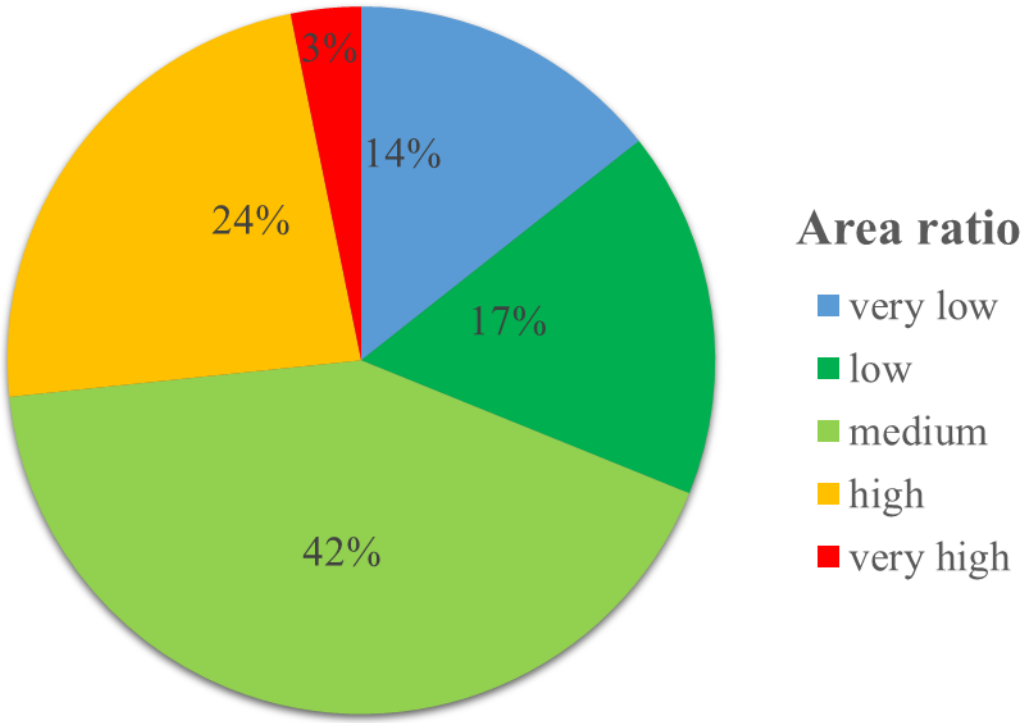
Methodology



Spatial Distribution of GDEs in China

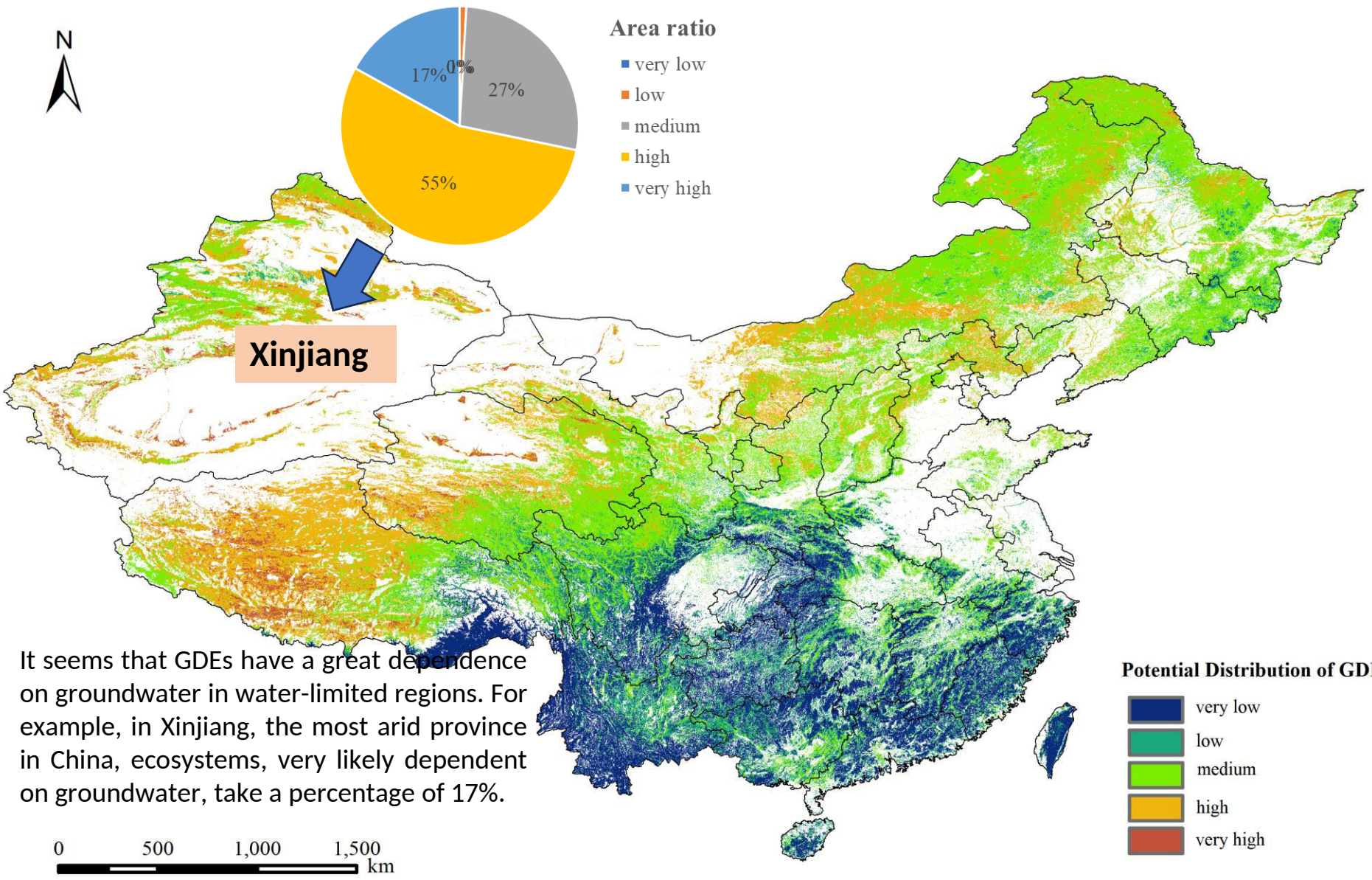


GDEs Dependency in China



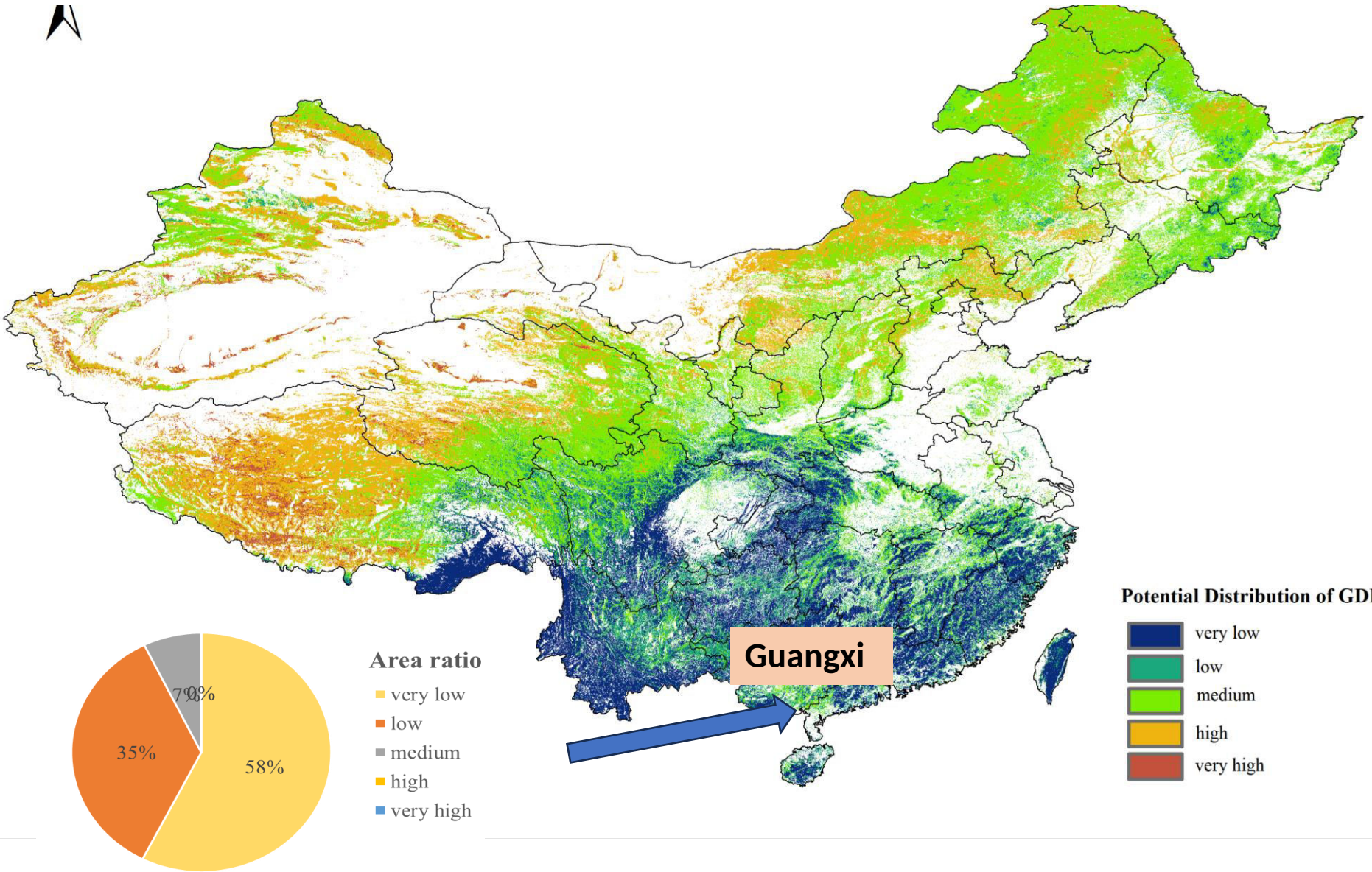
- The largest area in China is the GDEs medium potential zone
- The high and very high potential areas of GDEs in China is 27%, specifically, 3% is very high potential and 24% is high potential

Spatial Distribution of GDEs in China

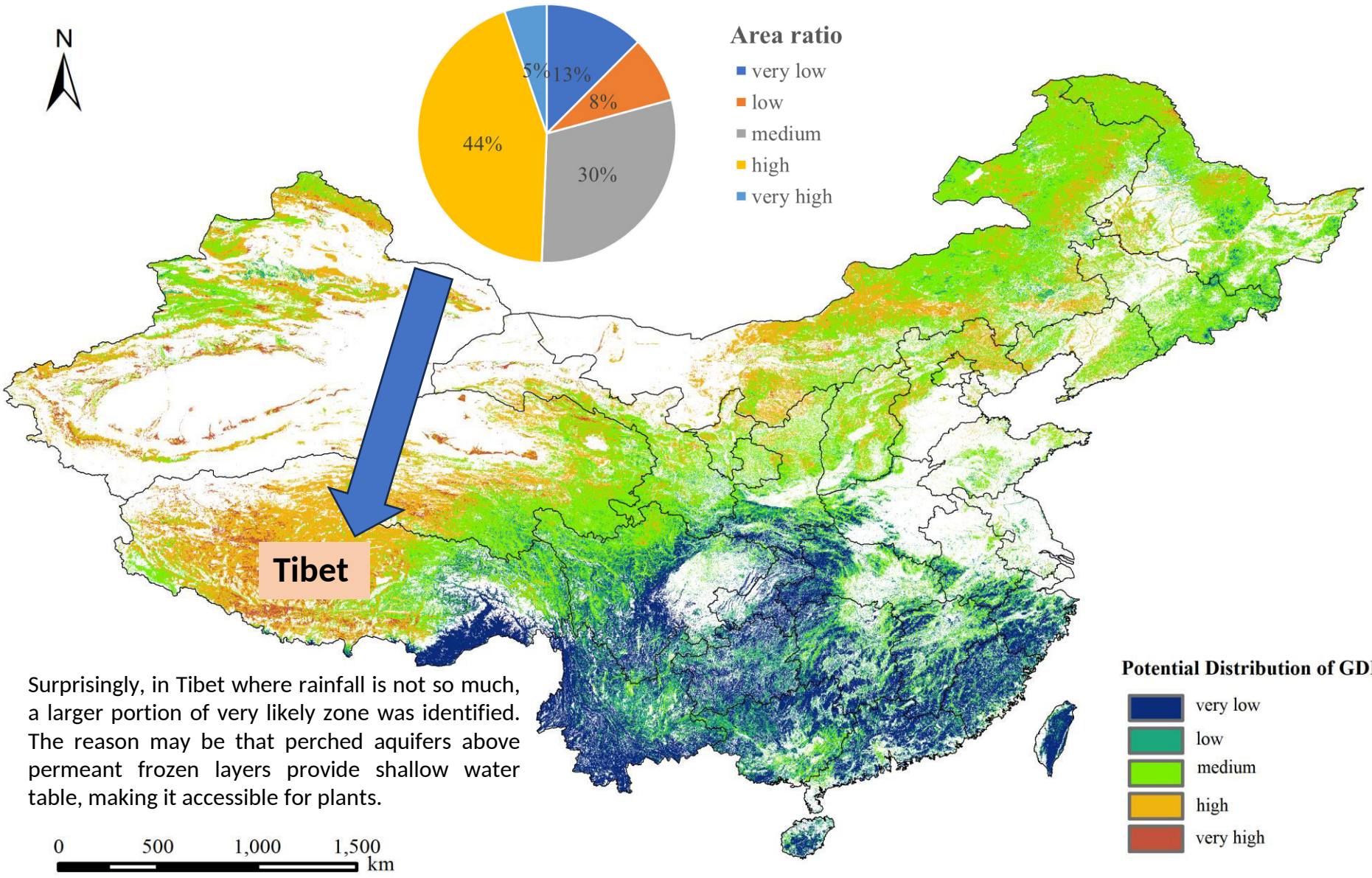


It seems that GDEs have a great dependence on groundwater in water-limited regions. For example, in Xinjiang, the most arid province in China, ecosystems, very likely dependent on groundwater, take a percentage of 17%.

Spatial Distribution of GDEs in China

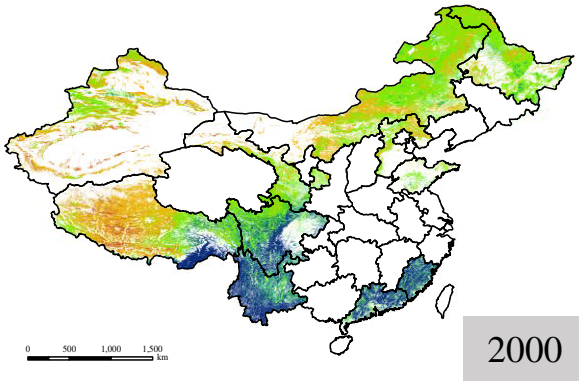


Spatial Distribution of GDEs in China

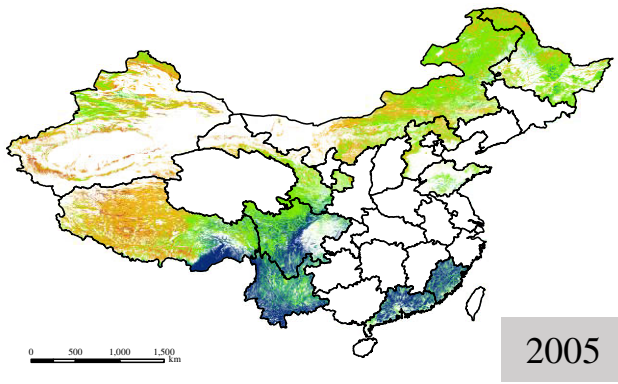


Surprisingly, in Tibet where rainfall is not so much, a larger portion of very likely zone was identified. The reason may be that perched aquifers above permeant frozen layers provide shallow water table, making it accessible for plants.

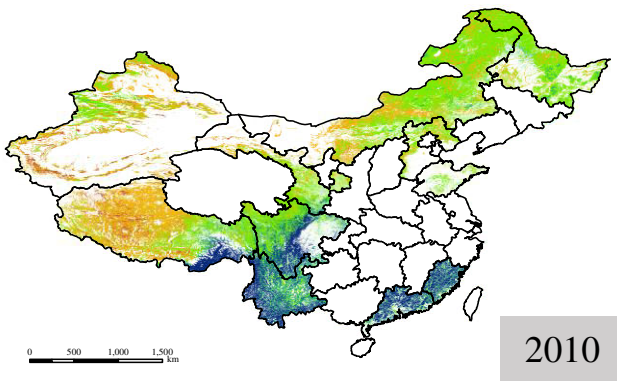
Temporal changes of GDEs in China



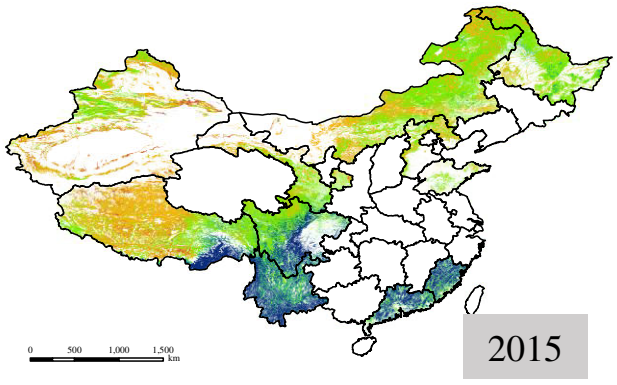
2000



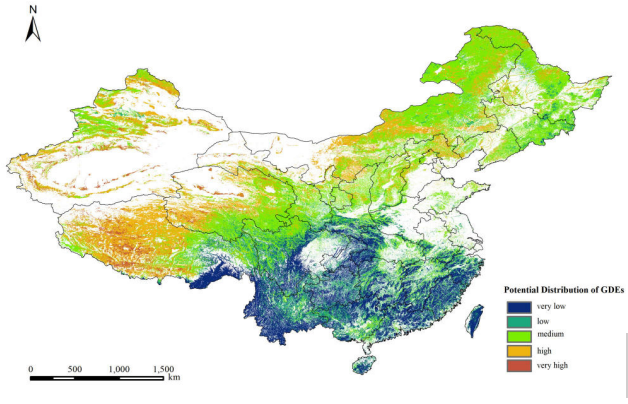
2005



2010



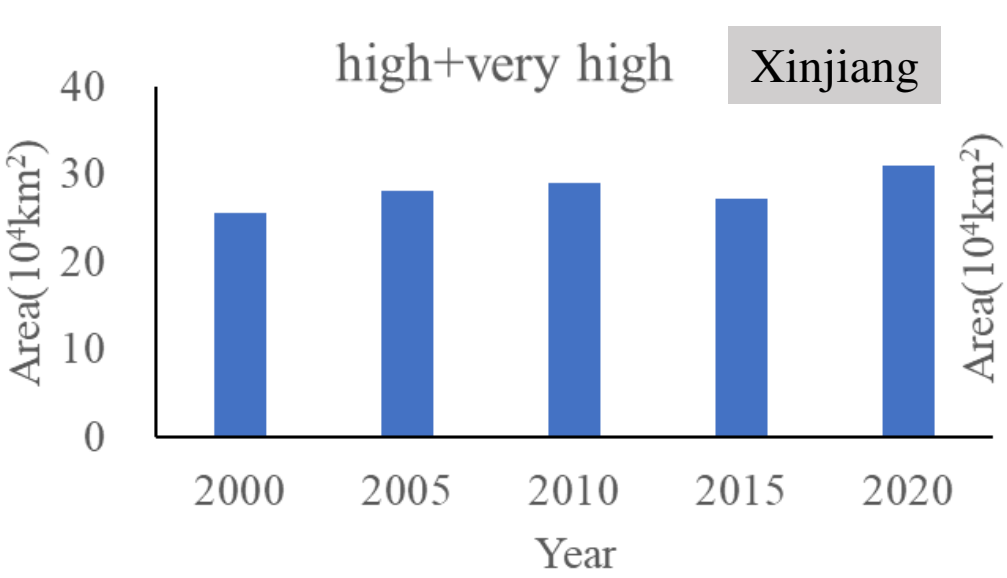
2015

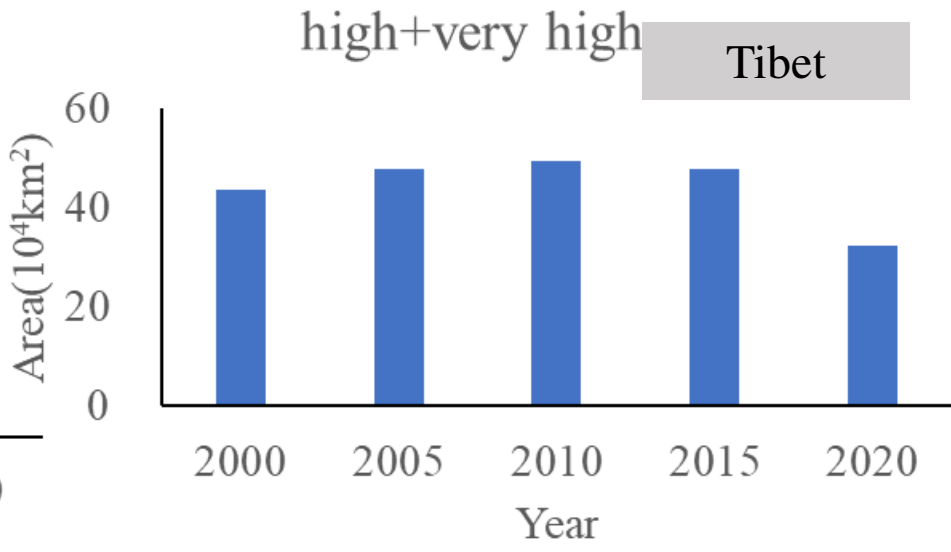


2020

Using the same method, GDEs distribution was obtained for recent two decades, at every five-year temporal resolution. Generally, the spatial pattern for different years keeps a similar distribution, but some changes have found.

Temporal changes of GDEs in China





For example, in Xinjiang, there is a slight-increase trend, that may attribute to large-scale ecological restoration programs. In Tibet, there is a sharp decrease after 2015, that may be caused by climate change. For the changes over time, still there are lots of open questions, detailed study is under way.

Thanks!