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

LECTURE 12 – Infrastructure Management and Planning

Lecturer: Dr. Tingneyuc Sekac, Ph.D. PNG University of Technology

Infrastructures

- Infrastructure refers to fundamental physical and technological frameworks that a region or industry establishes for its economy to function properly.

- All these underlying structures forming interrelated systems make people's lives easier, sustainable, and more comfortable.

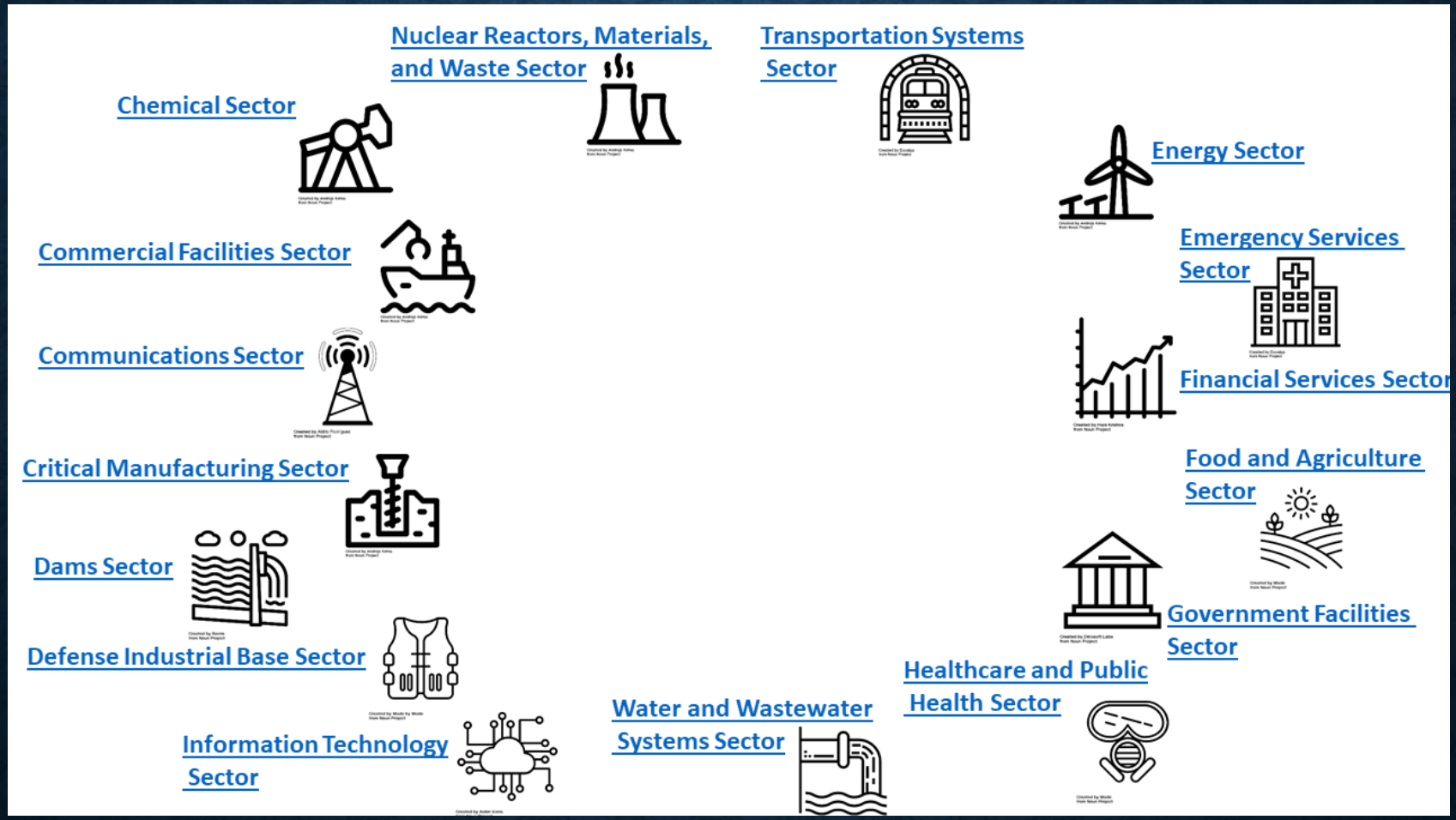
Infrastructures

- Districts, Towns and cities are comprised of different infrastructures of varying quality which may be impacted by hazards to differing degrees.

- Therefore Planning and Monitoring is Vital

Infrastructures

Critical Infrastructure sectors.



Source: Moulos, V. et al, 2018

Infrastructures

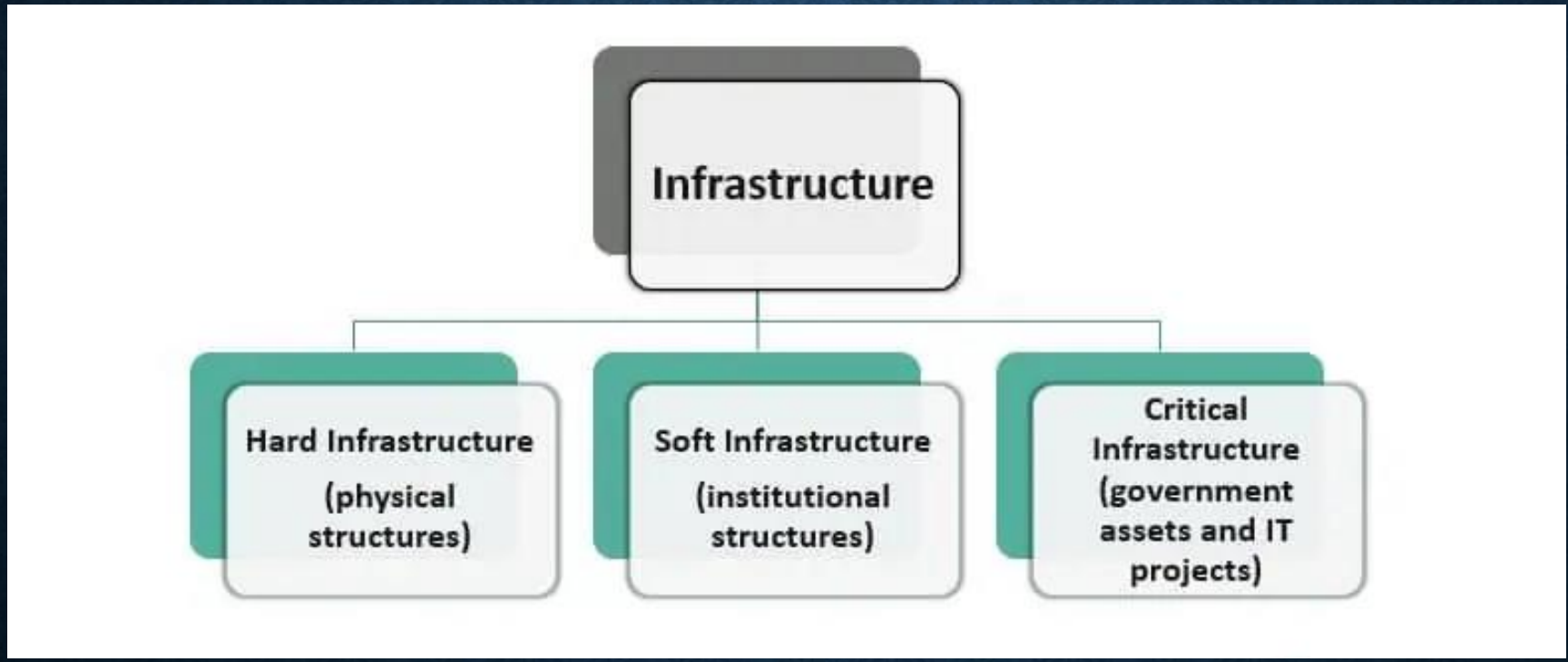
Source: https://marketbusinessnews.com/financial-glossary/infrastructure-definition-means/

Infrastructures

Source: https://www.lumina.com.ph/news-and-blogs/blogs/list-of-expressways-in-the-philippines/

Infrastructures

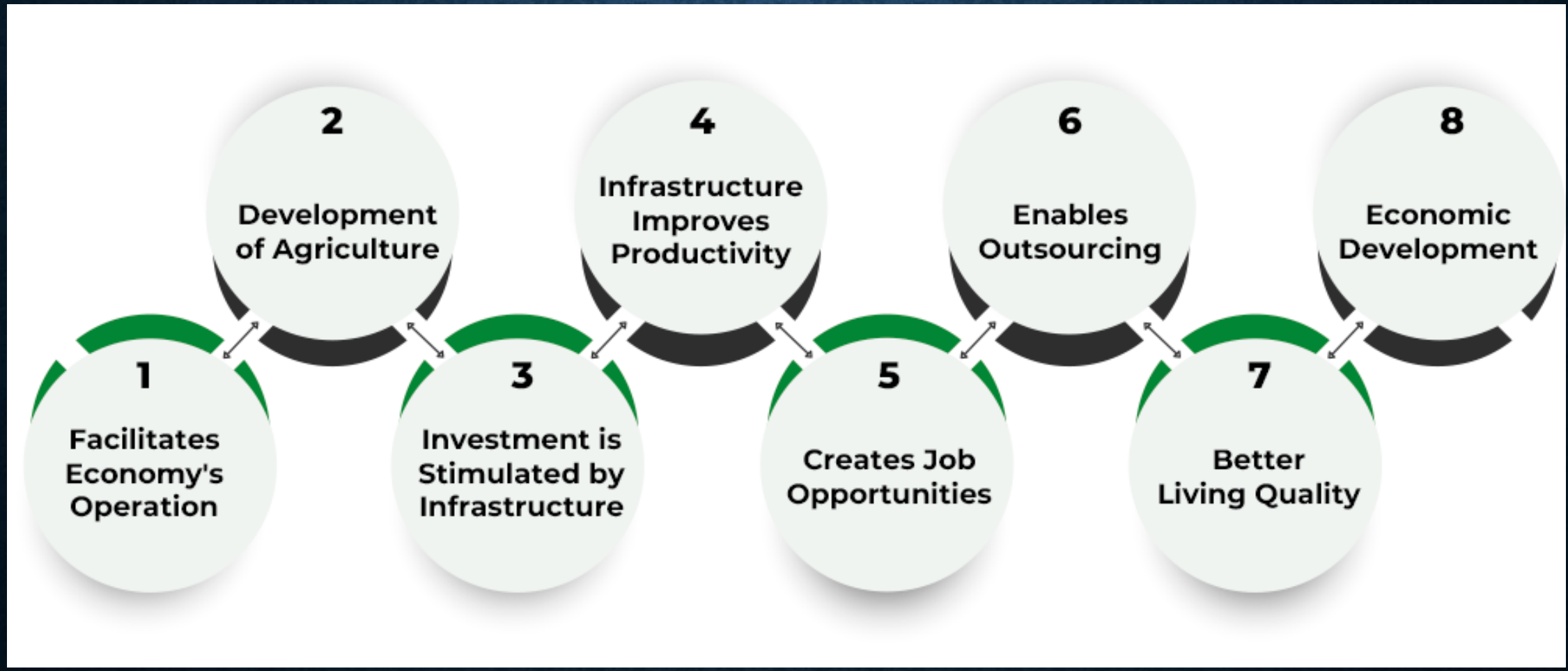
Infrastructure Type.



Source: WallStreetMojo, Online: https://www.wallstreetmojo.com/infrastructure/

Infrastructures

Importance of Infrastructure.



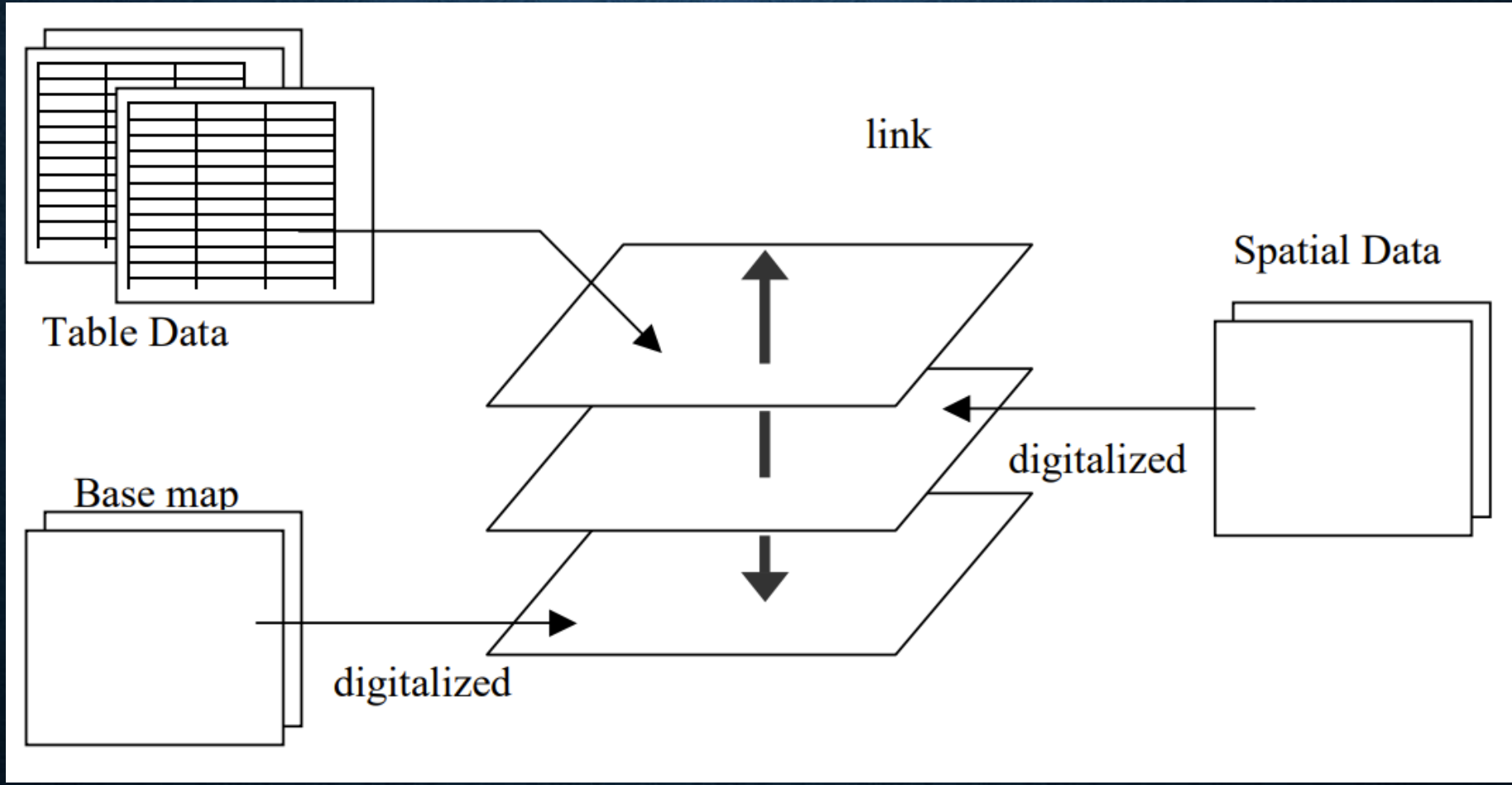
Source: https://www.geeksforgeeks.org/infrastructure-meaning-characteristics-importance-and-types/

Infrastructures Planning

- Infrastructure planning is critical to economic development.
- Maps generated from GIS helps plan and analyze a city´s and rural communities infrastructure needs.
- Application of GIS and Remote Sensign can significantly reduce operational and administrative costs and improve suitability of infrastructures.

Infrastructures Planning

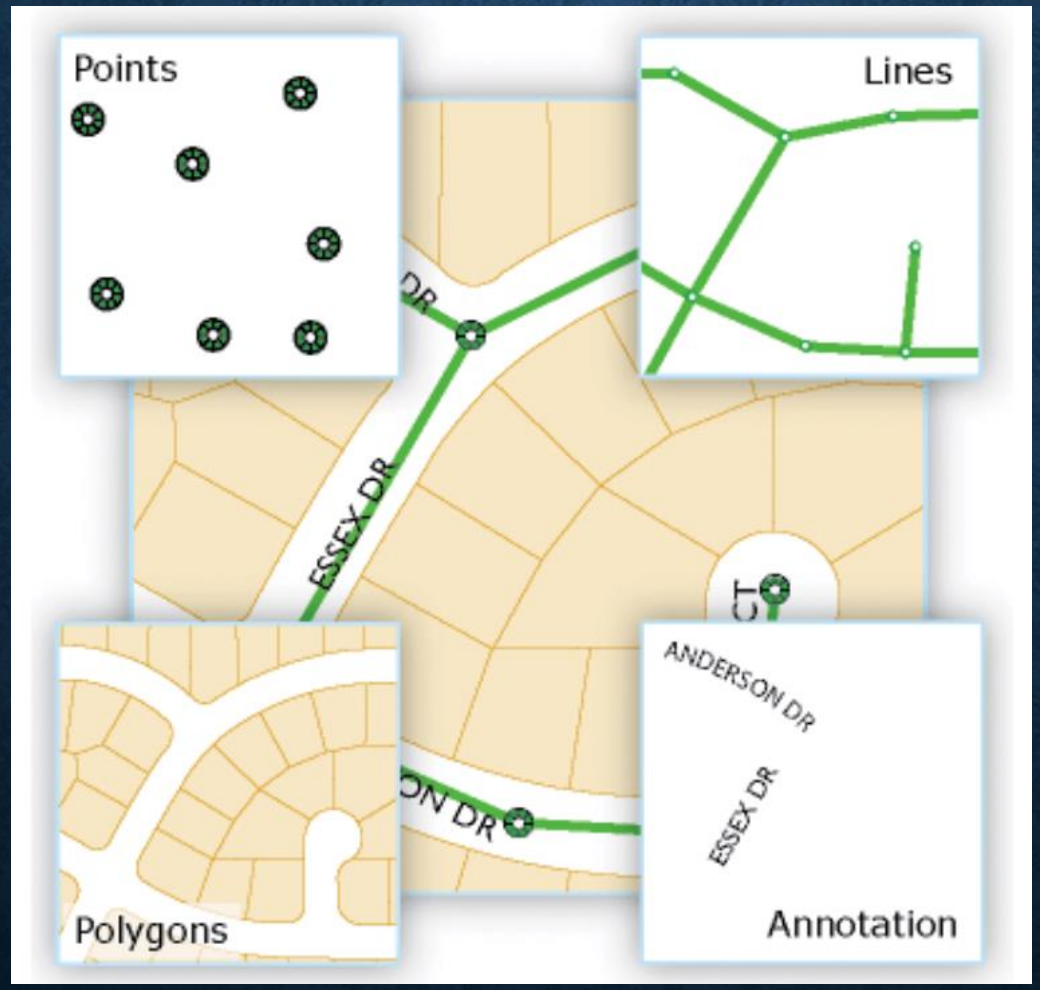
Formation of GIS System Concept



Source: JICA Study Team, Online: https://openjicareport.jica.go.jp/pdf/11640844.pdf

Infrastructures

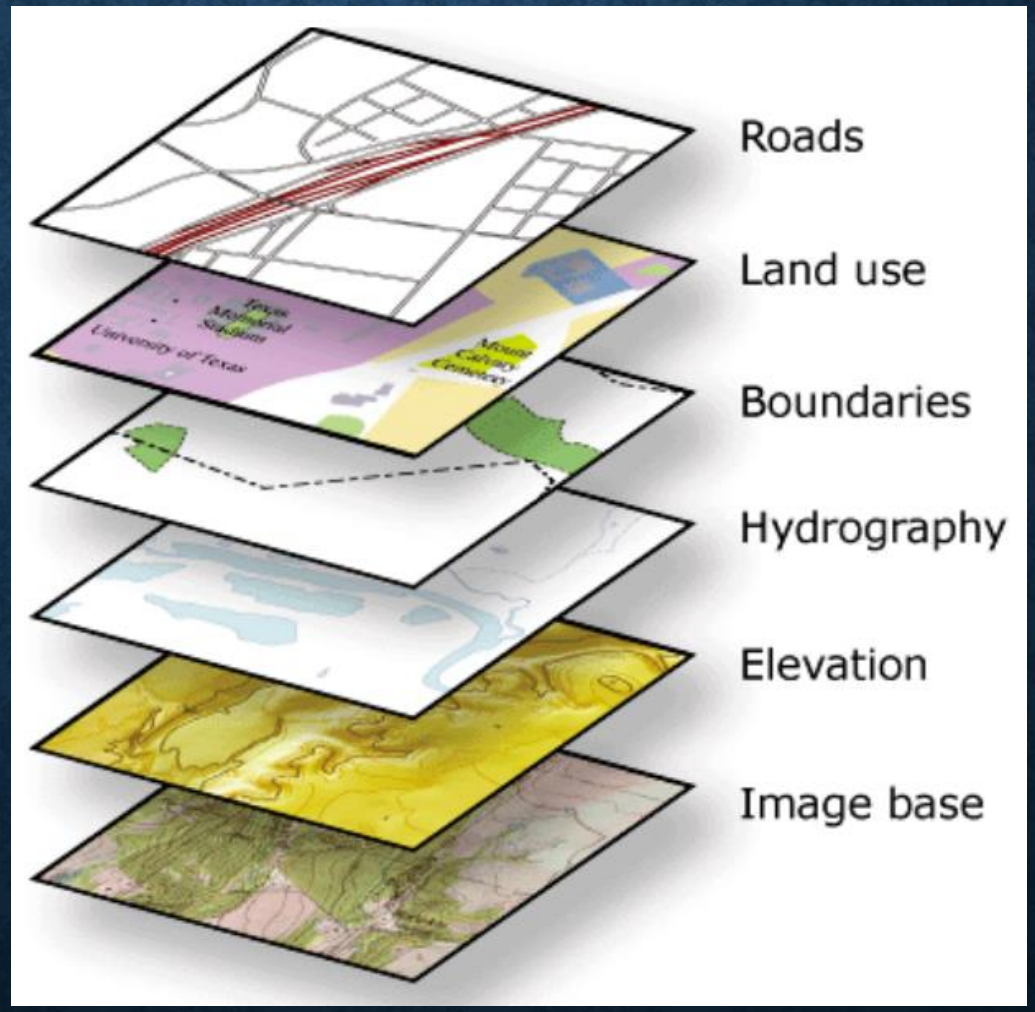
Formation of GIS System Concept



Source: http://webhelp.esri.com/arcgisserver/9.3/java/index.htm#geodatabases/feature_class_basics.htm

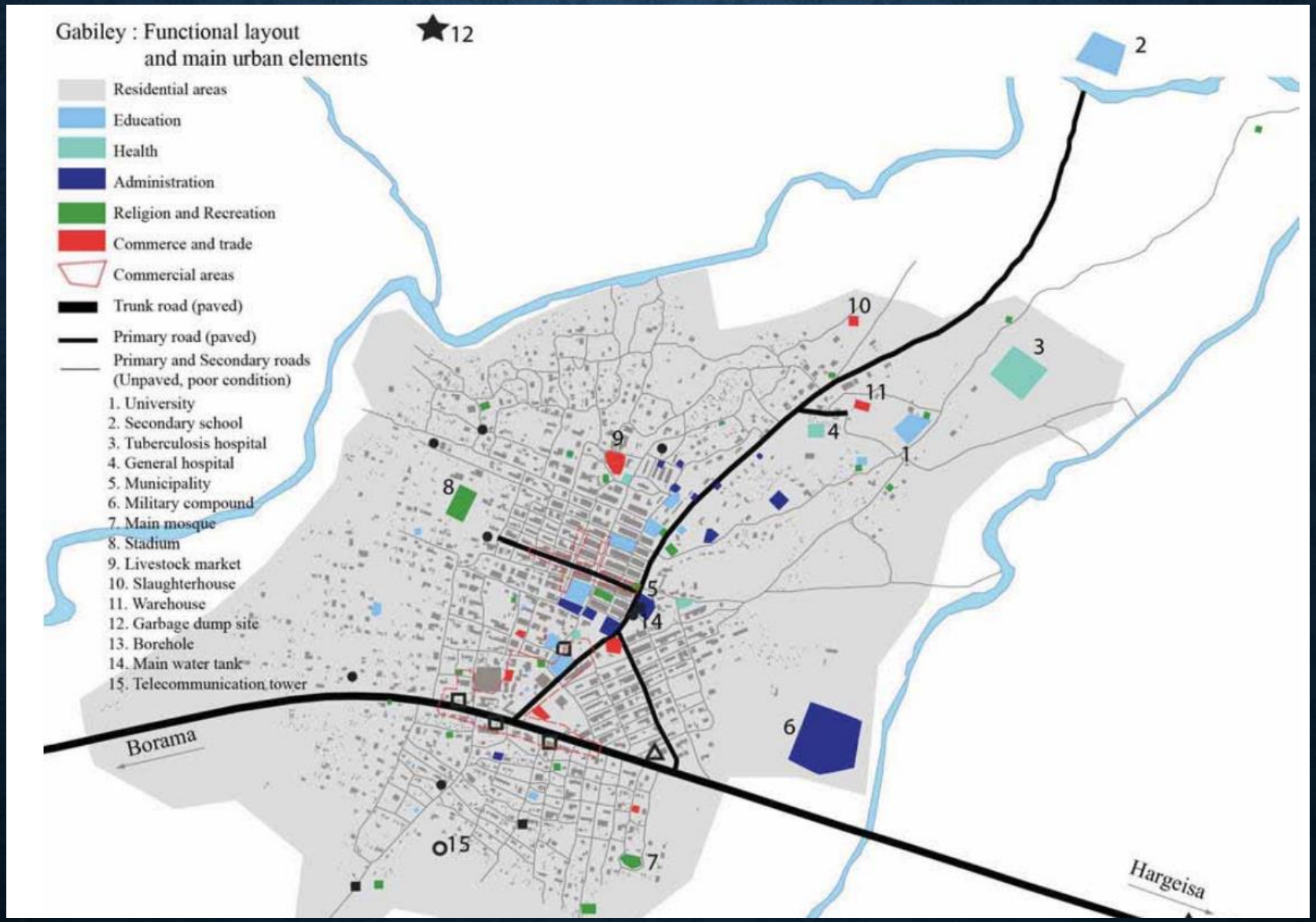
Infrastructures Planning

- Different types of information can be layered and overlaid as seen on below.



Source: http://webhelp.esri.com/arcgisdesktop/9.2/printBooks_topics.cfm?pid=22

Infrastructures Planning



Source: Gabiley Distrcit Profile, Online: https://unhabitat.org/sites/default/files/download-manager-files/GIS%20Handbook%20for%20Municipalities.pdf

Why Infrastructures Planning

- Infrastructures planning to avoid cost inflation
- Planning in such a way that it will have greater revenue in return. In more general term “greater economic impact”

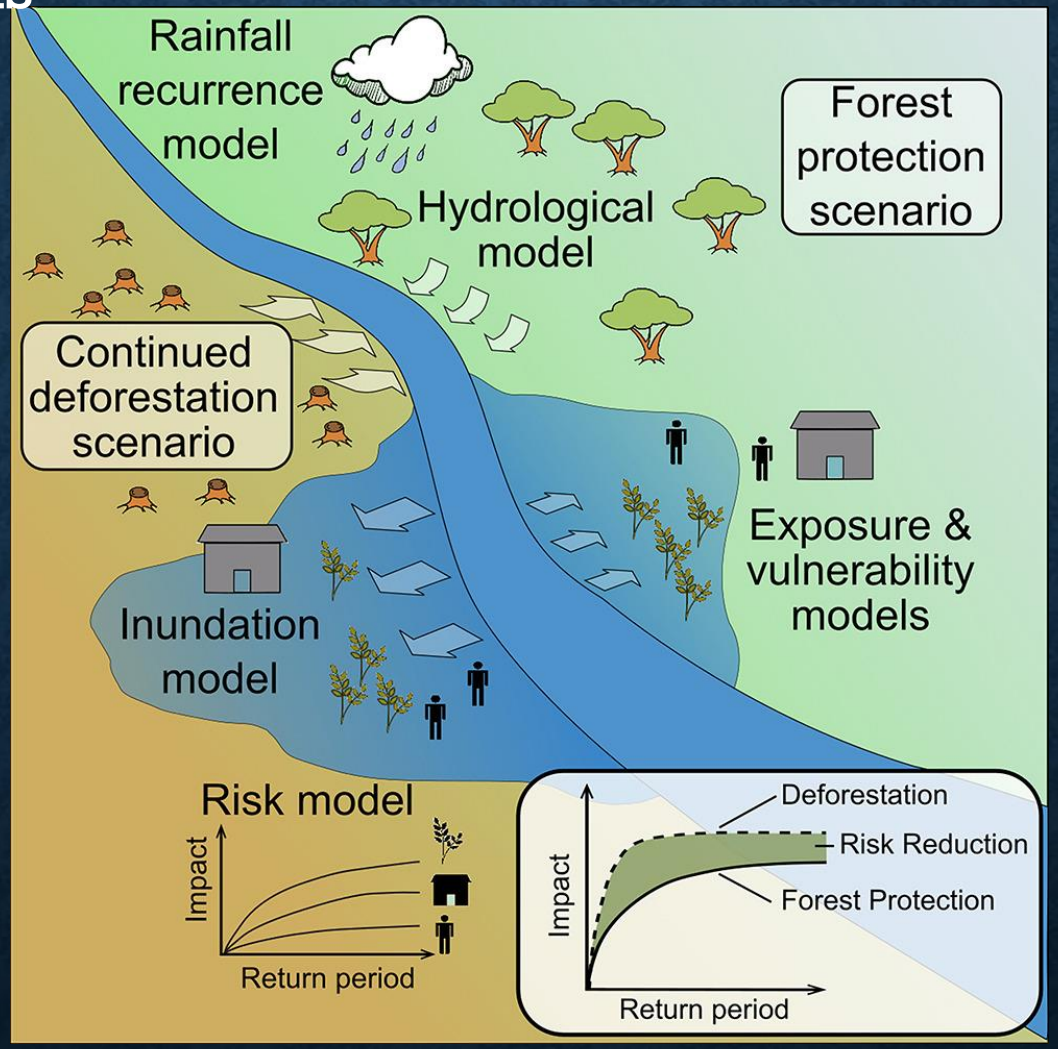
Why Infrastructures Planning

- Planning in such a way that to avoid infrastructures dangers to near by communities (EIA) and compensate accordingly.

Source: Pat Scullion, 2010 under CC BY-NC-ND 2.0, Onlne: https://opendevelopmentcambodia.net/topics/infrastructure/

Why Infrastructures Planning

- Planning in such a way that to avoid or reduce destructions due to various hazards



Source: David Lallemant et . All, 2021, Online: https://www.sciencedirect.com/science/article/pii/S2590332221004681

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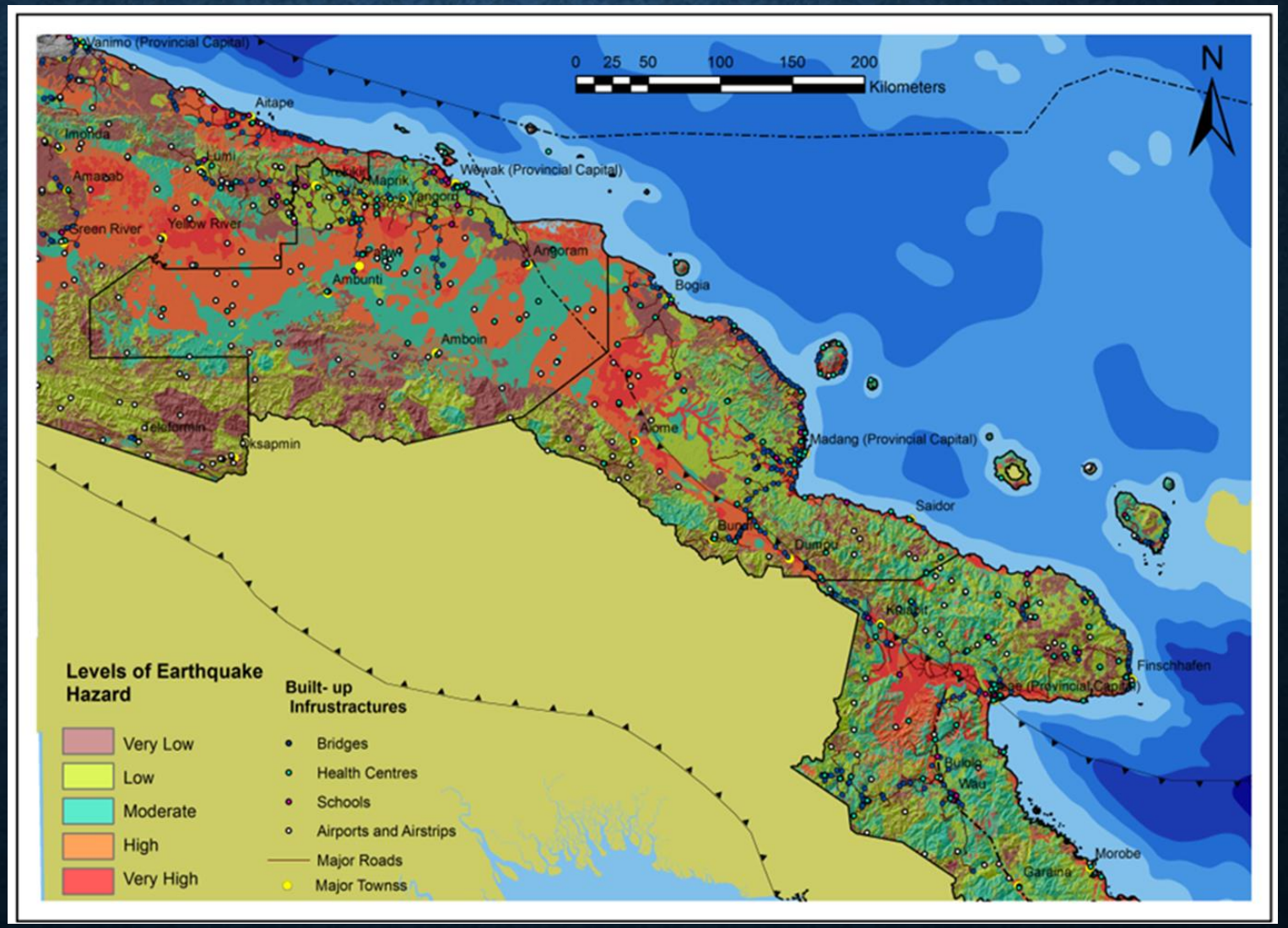

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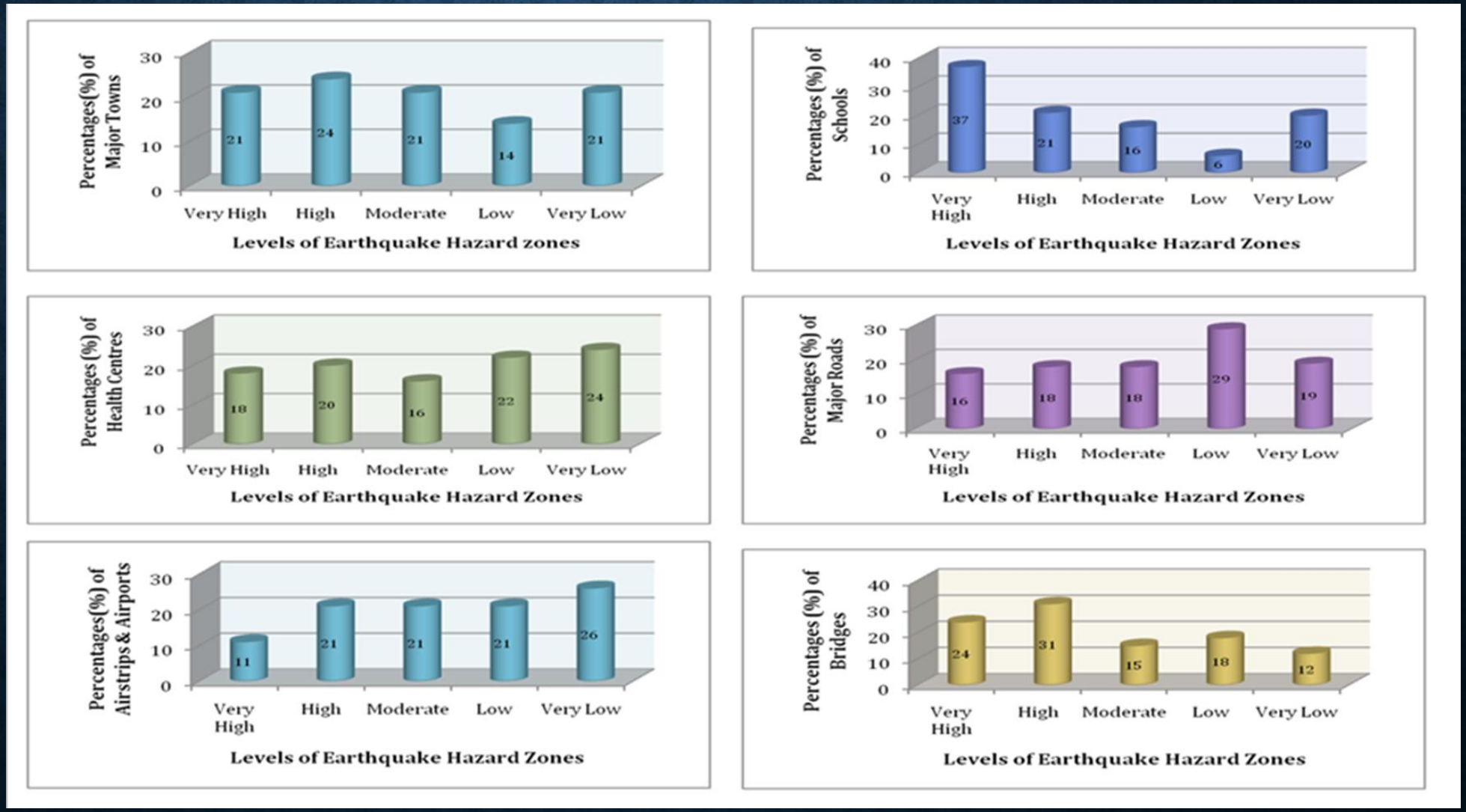
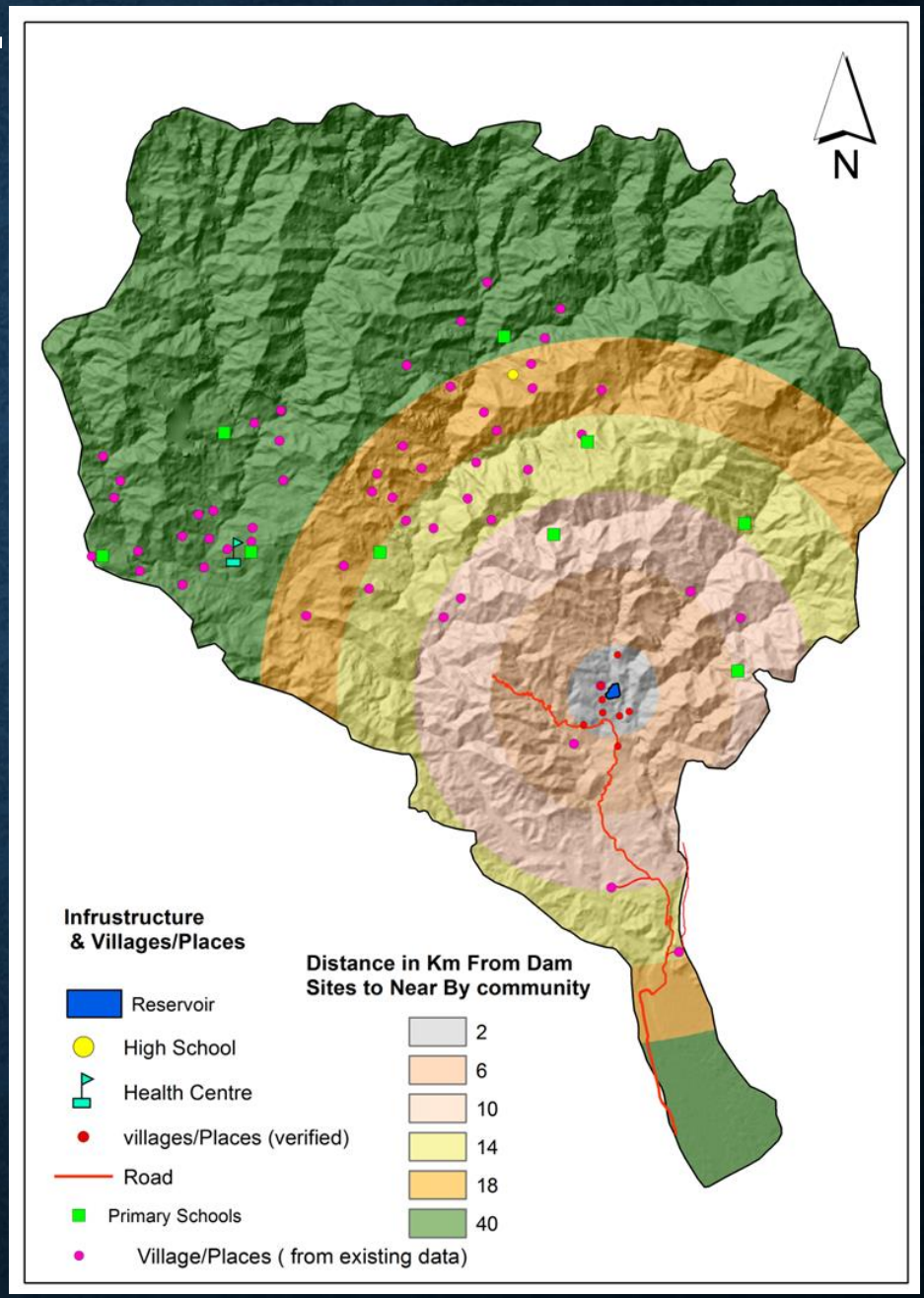


Why Infrastructures Planning

- Planning in such a way that it is sustainable and economic viable

Infrastructure Planning for Hydropower development – Case study in Busu Catchment

Main geo-features to consider during hydro power plant development are the people and places that the power will supply to

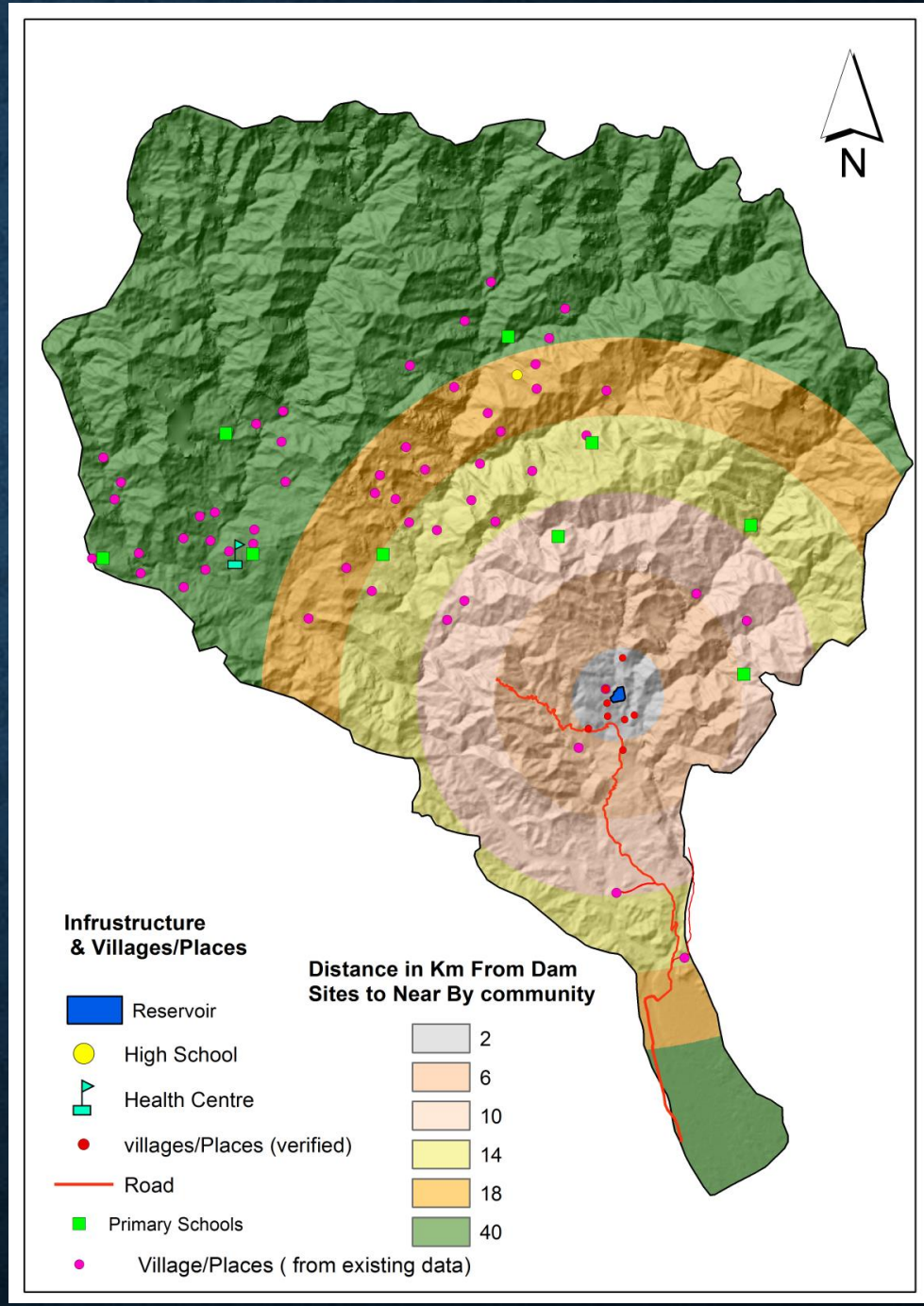


Why Infrastructures Planning

- Planning in such a way that it is sustainable and economic viable

The approach of considering the distance between the dam site and community is paramount
Important in terms of;

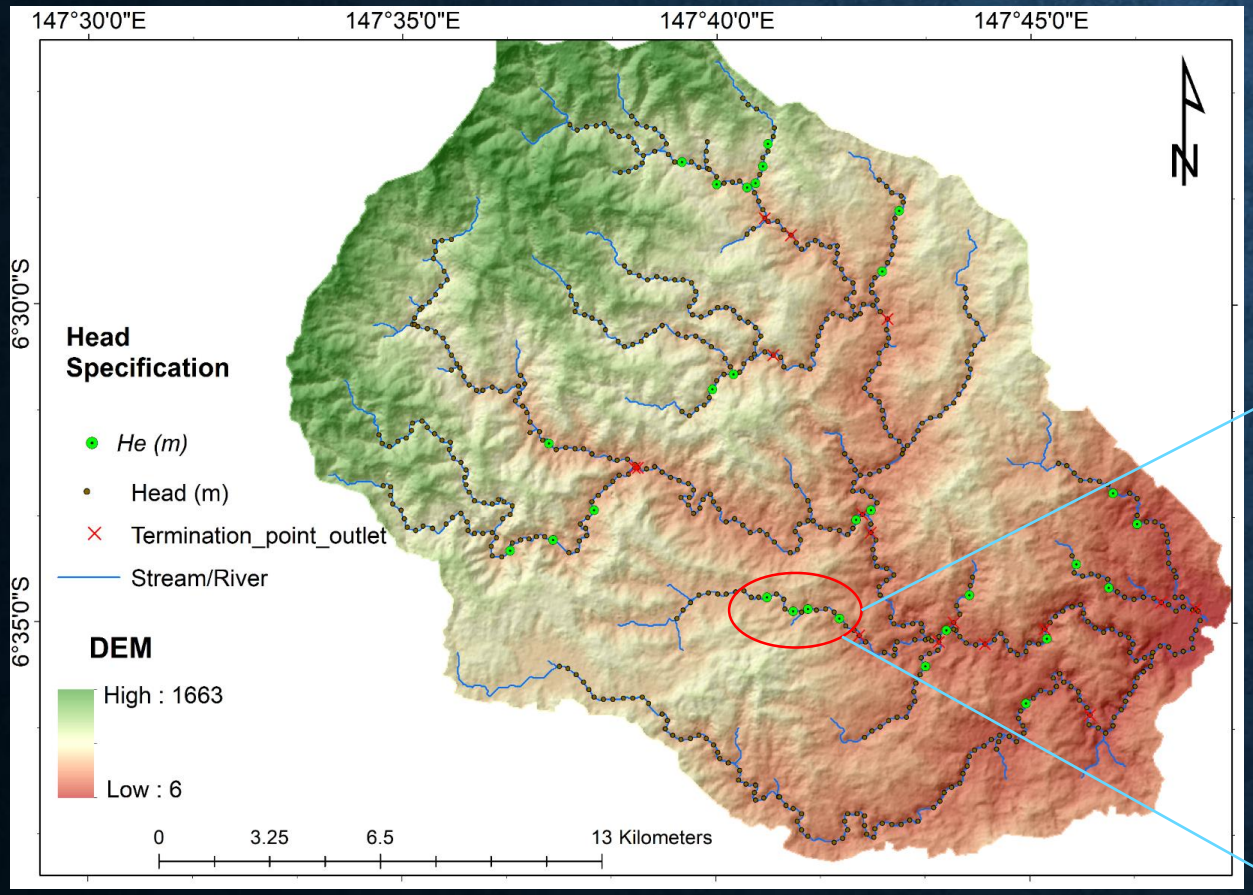
a. Servicing
b. Security
c. Efficient power distribution to each house hold or villages
d. flow information of the river/stream



Why Infrastructures Planning

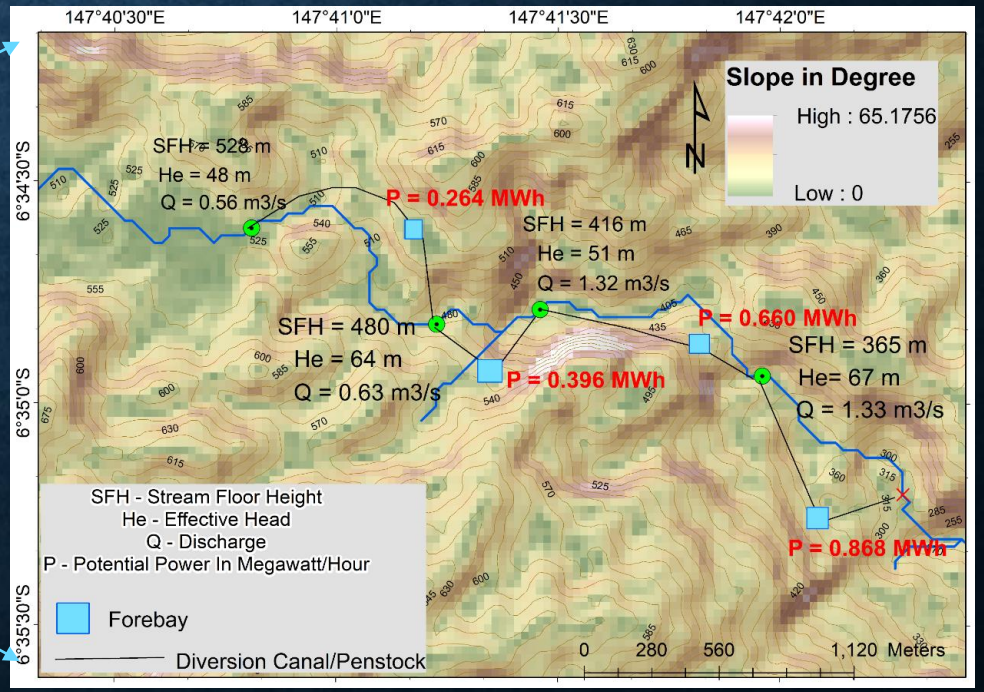
❖ Planning in such a way that it is sustainable and economic viable

Infrastructure Planning for Run-of Hydropower development – Case study in Mape Catchment



Criteria used for Head Specifications;

- Flow Accumulation/flow discharge
- Vertical and Horizontal head Distance
- Slope/Topography
- Infrastructure/proximity



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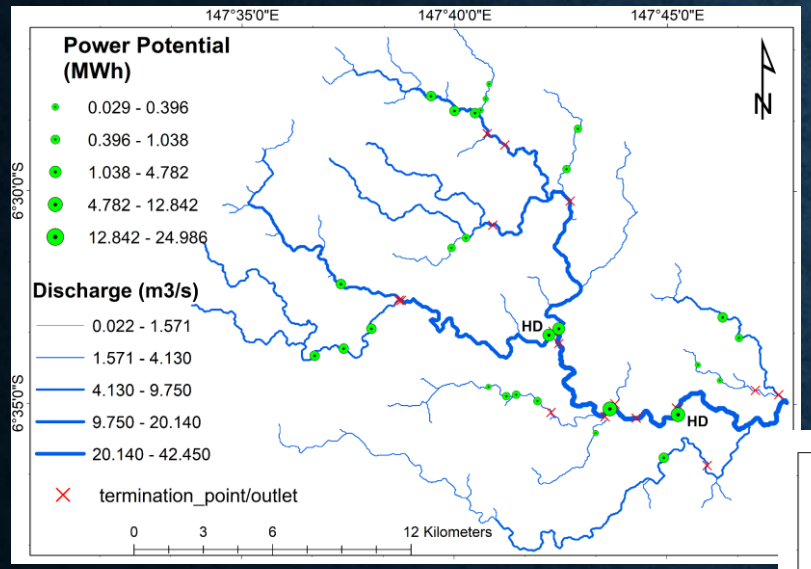

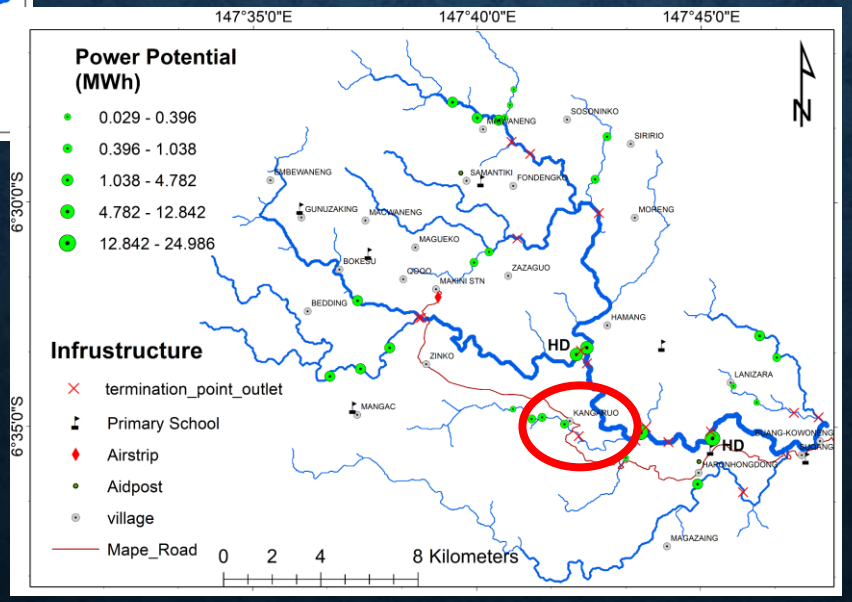

- 29 Hydropower potential sites Identified.
- Hydropower Potential ranges from 0.029 – 24.99 MWh

Two sites considered as Hydro Dam (HD)

Sample village considered for economic and consumption rate analysis.

Why Infrastructures Planning

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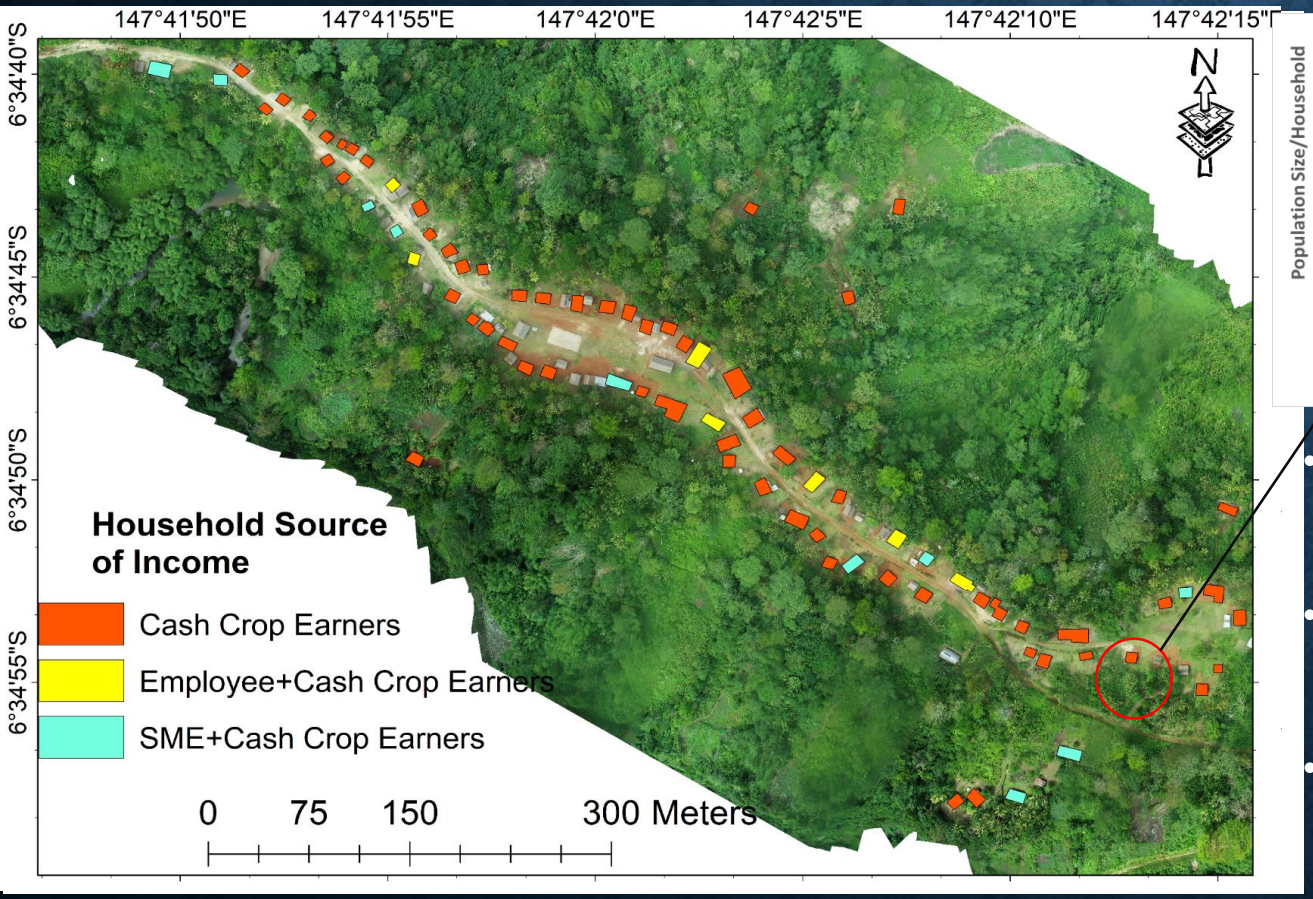

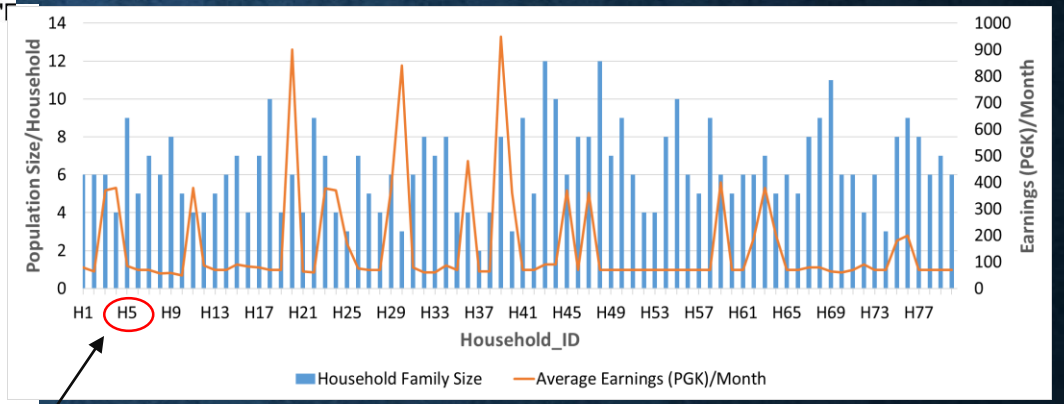

- 80 household; 78% cash crop earners, 13% SME + Cash Crop Earners, 9% Employee + Cash Crop Earners.
- Average earnings per month for each household; USD 20.30 – USD 85.23
- 90% of the population found to be economically viable to sustain electricity at the Tariff rate between US 0.150 – USD 0.200 per kWh.

Why Infrastructures Planning

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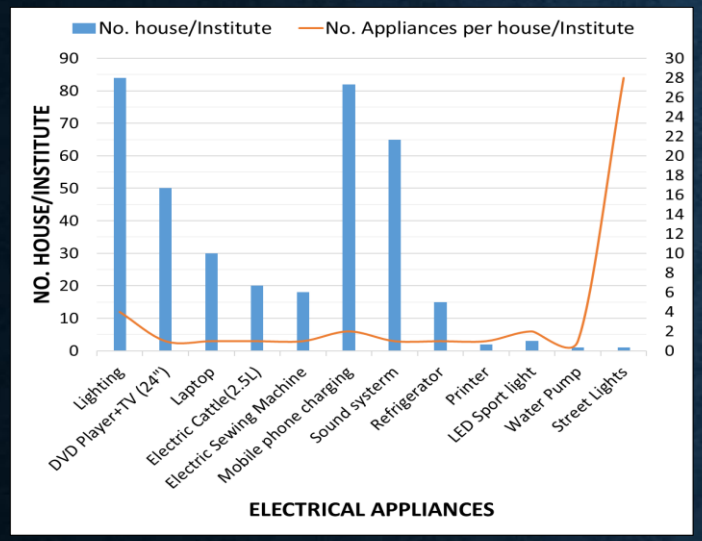
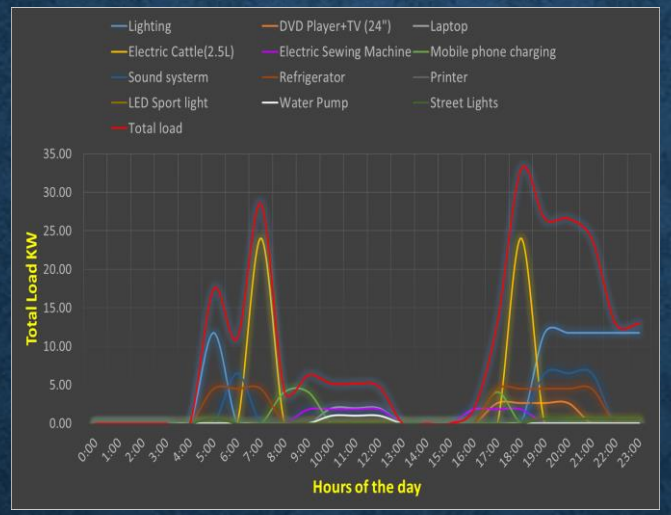
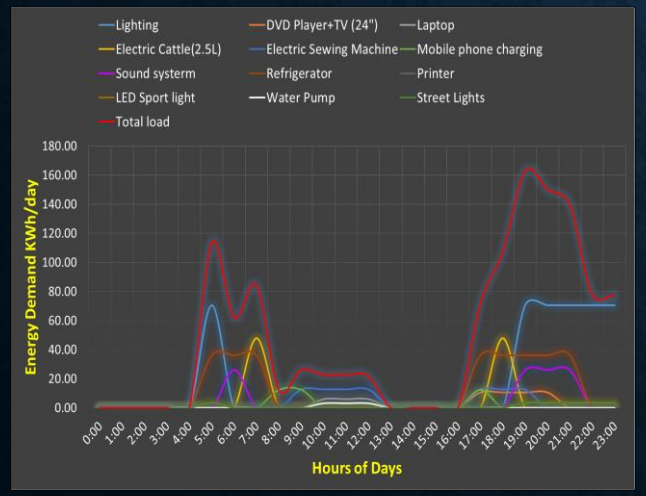
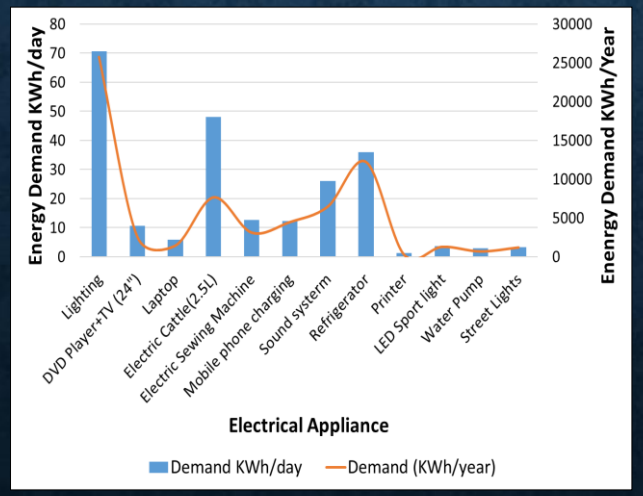
Infrastructure Planning for Run-of Hydropower development – Case study in Mape Catchment









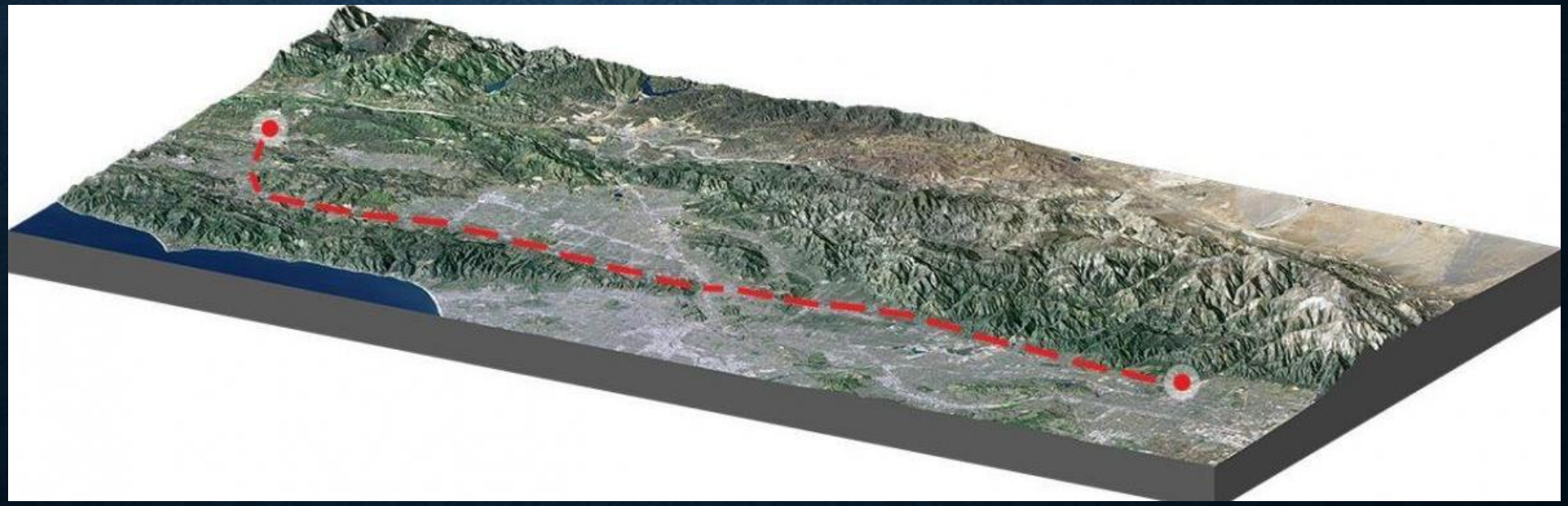
- Number of household and Electrical appliances for load categorizing and profiling.
- The load profile for 24 hours' time.
- System sizing for Kangaruo village = 40KW (Peak Load)
- Peak demand for kangaruo village in a day = 163 kWh in a day)
- **Total energy demand for the village = 233 kwh/day and 67,486 kwh/year**

Why Infrastructures Planning

- Planning in such a way that it is sustainable and economic viable

Mapping distance:

- Cost Weighted Distance
  - Straight line/Euclidean distance
  - Shortest (or least-cost) path.



Source: GISGeography, 2022

Why Infrastructures Planning

- Planning in such a way that it is sustainable and economic viable

Raster Data Encoding – The Cell Values

Source: Dr. Fang Qiu

Why Infrastructures Planning

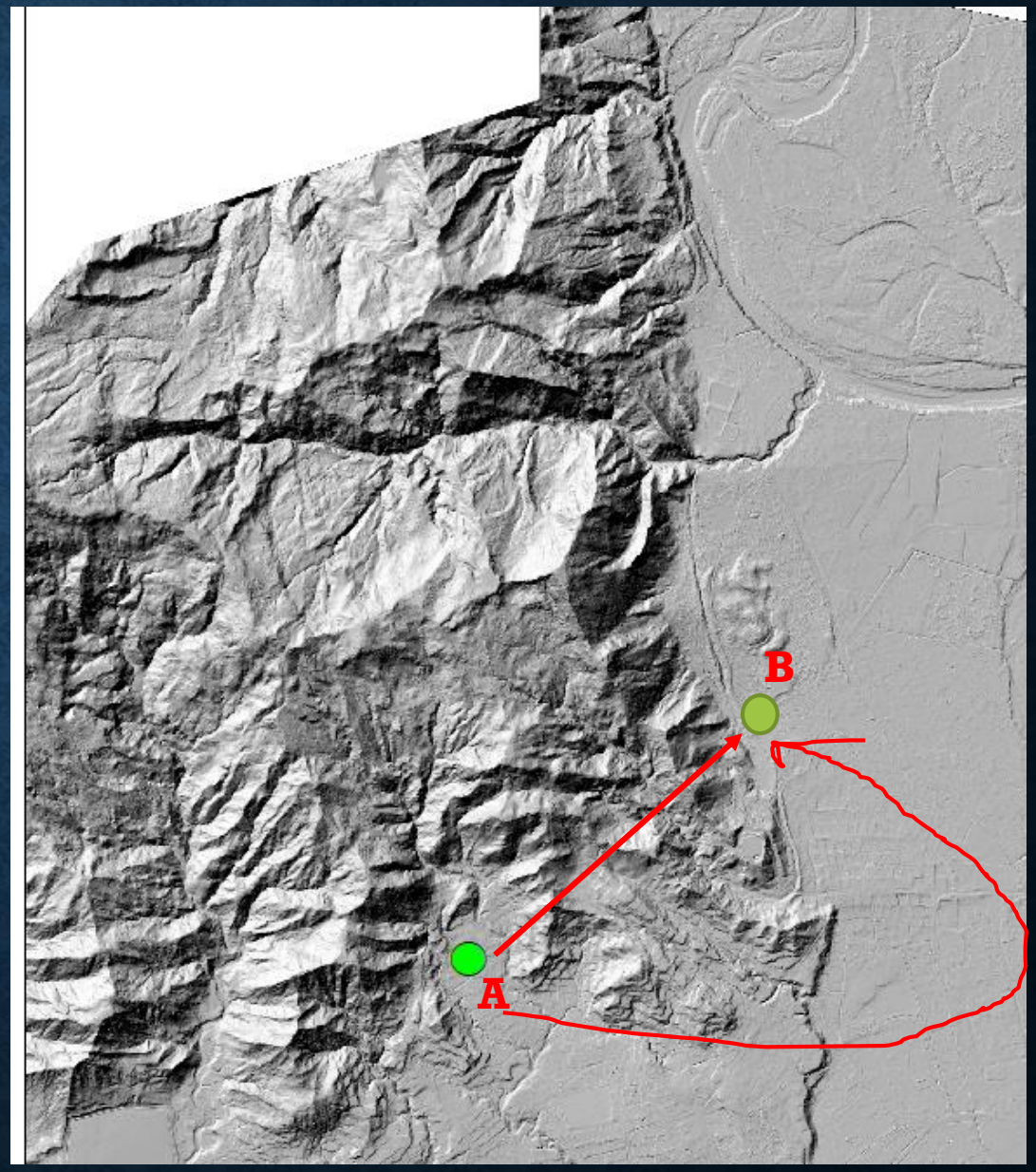
❖ Planning in such a way that it is sustainable and economic viable

Least cost path for Road linking

From Point A to Point B

To identify a least cost path for a new road link, the cost weighted distance function is used

- To calculate the least accumulative cost the source and a cost raster is needed by cost distance weight function.



Why Infrastructures Planning

- Planning in such a way that it is sustainable and economic viable

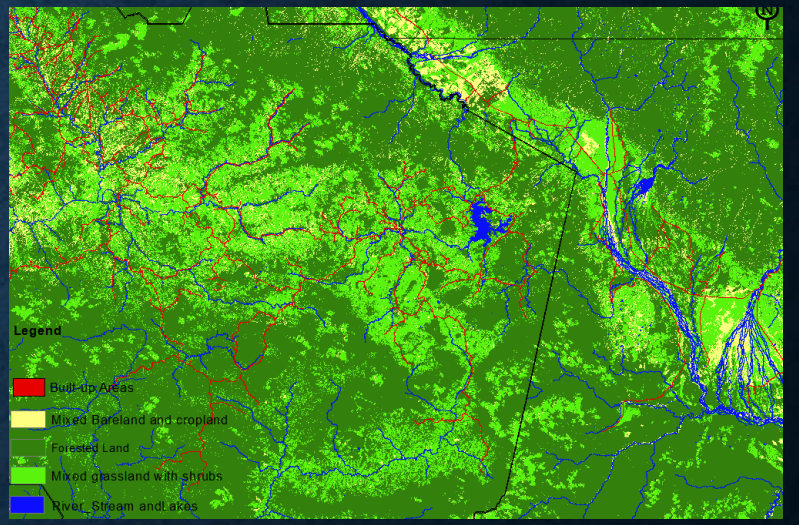
Cost Raster

- The cost Raster identifies cost of travel to every cell.
Weight values assigned to each class level.

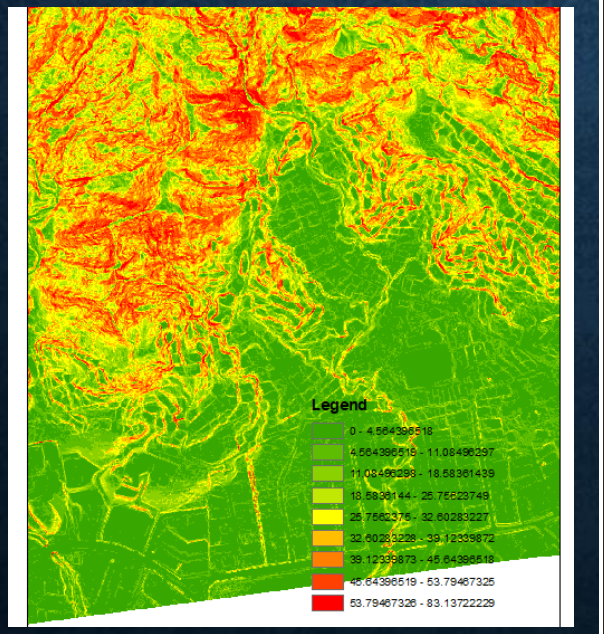
- Higher the weight value, more the cost.

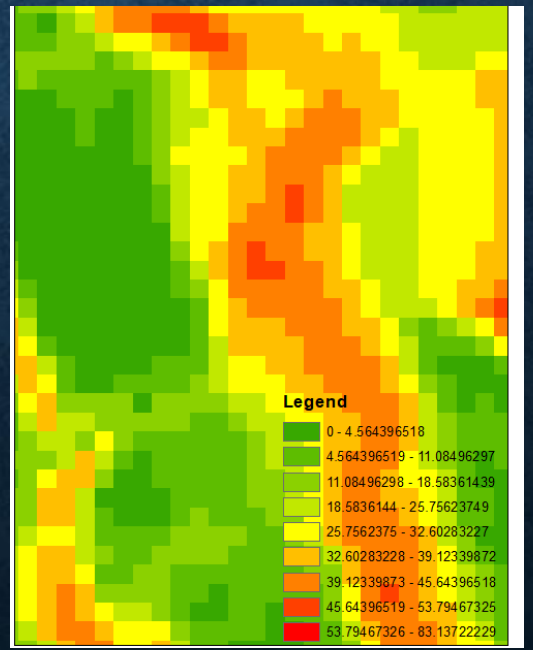
- Example, steep slope of class 54 degree to 83 degree slope will be assigned higher weightage since it will incur more cost of construction towards steep slope.

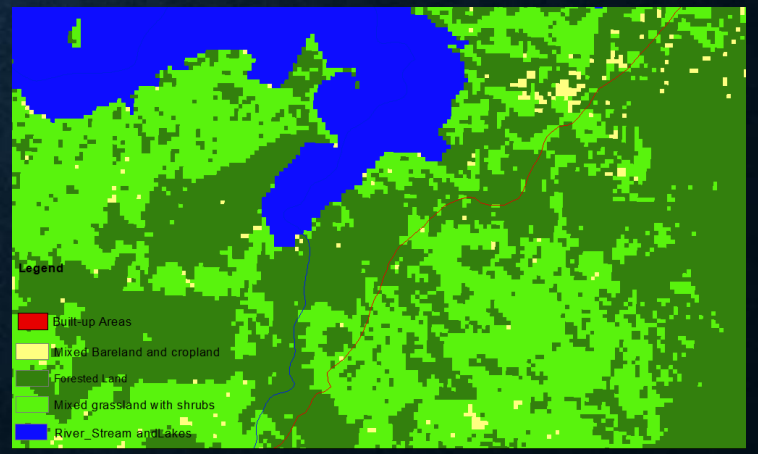
Land use Land Cover



Slope







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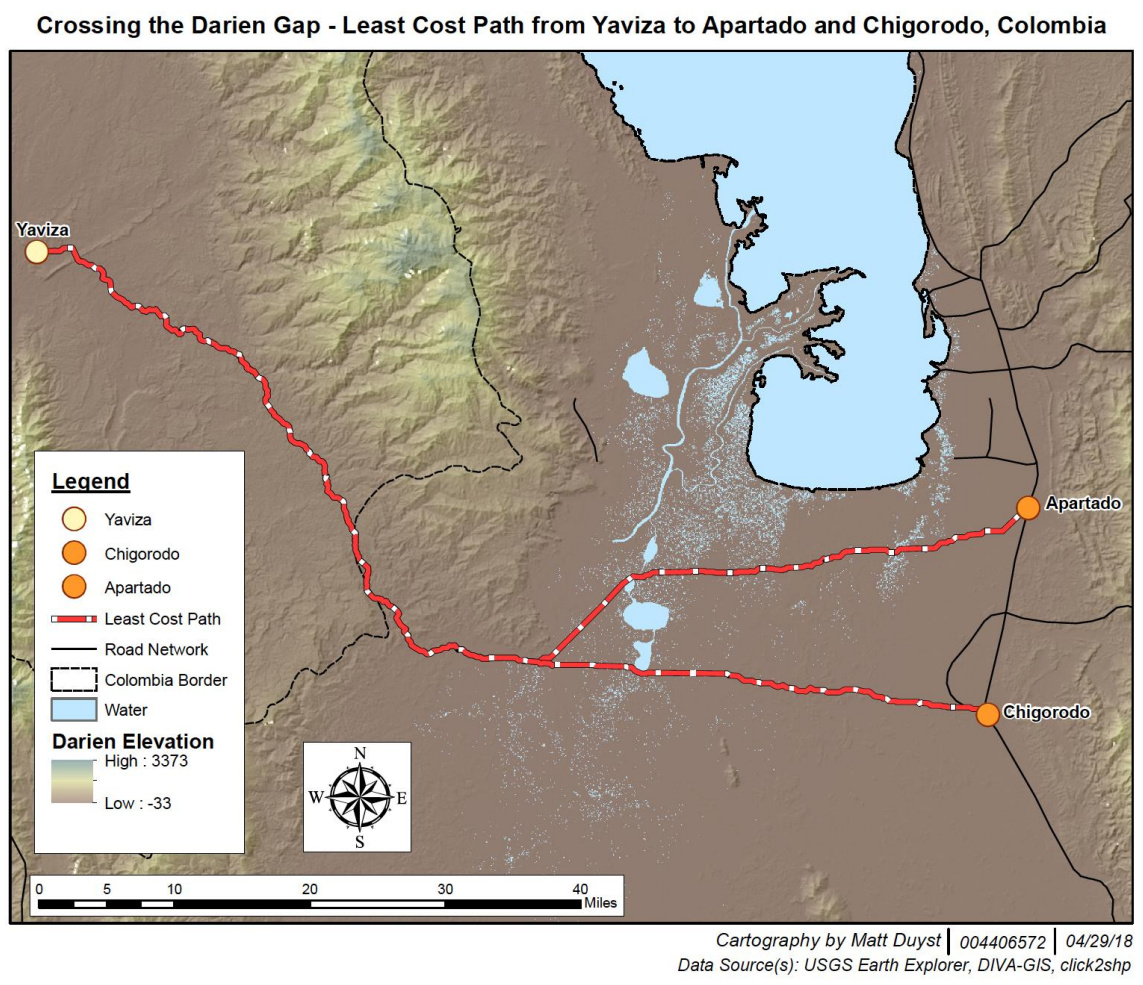

The map above illustrates the most affordable method of building a road between Yaviza to Chigorodo and Apartado:

where the;
- slope is least,
- the presence of water is bare to minimum,
- the total flow accumulation of water is marginable.

Source: https://mappingwithmatt.com/2015/09/07/Darien-Gap/

References:

Moulos, V.; Chatzikyriakos, G.; Kassouras, V.; Doulamis, A.; Doulamis, N.; Leventakis, G.; Florakis, T.; Varvarigou, T.; Mitsokapas, E.; Kioumourtzis, G.; et al. A Robust Information Life Cycle Management Framework for Securing and Governing Critical Infrastructure Systems. *Inventions* **2018**, *3*, 71. https://doi.org/10.3390/inventions3040071.

David Lallemant, Perrine Hamel, Mariano Balbi, Tian Ning Lim, Rafael Schmitt, Shelly Win (2021). Nature-based solutions for flood risk reduction: A probabilistic modeling framework, One Earth, Volume 4, Issue 9, Pages 1310-1321, ISSN 2590-3322, https://doi.org/10.1016/j.oneear.2021.08.010. (https://www.sciencedirect.com/science/article/pii/S2590332221004681)