The Fourth International Workshop on GIS Technology and Application

Application of GIS in Civil and Environmental Engineering

Prof. Md. Sirajul Islam, PhD

Professor, Department of Civil and Environmental Engineering (CEE) Director, Center for Infrastructure Research and Services (CIRS) ... North South University

Why Civil and Environmental Engineering ?

- Previously only "Civil Engineering"
- Nowadays renamed as "Civil and Environmental Engineering"
 - Two or three decades ago, civil engineering was very much focused on the design and construction of structures only.
 However, over the years, civil engineers realized that the impact of any development on its surrounding environment cannot be ignored. Because such ignorance may create negative consequences and pose a threat to the environment. EIA requires for most of the big civil construction.
- All the structures built by civil engineers are in nature i.e. building, road, bridge, dam, barrage, etc.
- So, the consequence of those structure on environment must be understood clearly and take measures.



Branches of Civil Engineering

- Structural Engineering
- Geotechnical Engineering
- Transportation Engineering
- Water Resources Engineering
- Environmental Engineering





Branches of Civil Engineering and Environmental Engineering

- Structural Engineering
- Geotechnical Engineering
- Transportation Engineering
- Water Resources Engineering
- Environmental Engineering





Structural Engineering

Force analysis and strengthening the structure to withstand all those forces

- Building: Layout, design and maintenance
- Truss and steel structures
- Tower
- Bridge
- and many more types of structures

Sub-components

- Construction Engineering and management
- Building Information System or Modeling





Geotechnical Engineering

Soil property, mechanics and foundation of a structure.

- Building foundation
- Embankment
- Road base
- Bridge pier
- Slope stability, etc.

Further

- Strengthening soil
 - Geotextile use

- Natural disaster prevention like Land slide, Soil pollution or Erosion protection



Transportation Engineering

Road, railway, subway, tunnel, flyover, elevated expressway, river/sea port or airport runway.

- Road/Rail Layout,
- Structural Design of pavement/Track,
- Traffic Analysis,
- Transportation planning and management

Further

- AI use in traffic management
- Advanced transportation material

Nausori Airport Route 1 Diversion

TO KUKU

New diversion route is through Nadali Village. Portion of Kuku Road will be closed off to allow for Nausori Airport Extension Project.

NADALI VILLAGE

Legend

- A Nausori Airport
- So Nausori Airport Road Diversion
- Road

NAUSORI AIRPORT RUNWAY

- Section of Kuku Road to be Closed
- Section of Kuku Road to remain open

NEW DIVERSION ROUTE THROUGH NADALI



NEW ROAD

TO NAUSORI

ROAD

SECTION OF KUKU ROAD TO BE

ROAD TO BE CLOSED (400M)

ROAD

WAINIBOKASI ROAD

Google Earth

image © 2020 Maxar Technologies

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Water Resources Engineering

Any structure over a river, overall hydrology of a region, Hydrodynamic study or water related natural disaster

- Structure: Bridge, Dam, Bararge, Regulator, etc
- Irrigation system and structures
- Embankment
- River erosion protection
- Dredging, Land reclamation, etc.

Further

- Climate change impact study
- Sea level rise, salinity issues
- Advancement in water related natural hazard protection like Flood, River Erosion protection, salinity control.





Day to day environmental issues are mostly covered by civil engineers as water supply, sanitation, waste management. Also known as Public health Engineering

- Two major urban utilities: Water supply and Sanitation/sewage management,
- Solid waste management,
- Drainage: idea of Sponge city in China
- Pollution control: Water quality, ETP/STP/WTP

Further

- Climate change and Disaster management study
- Sea level rise, salinity and water supply issues
- Technologies for adaptation to climate change
- Green technology: Green building, infrastructure



Example: GIS application in Civil

- Civil engineering structures are always exposed to nature directly.
- The location of the structure in the earth is the first question How the topographical features will affect the
- design of structure is the next question.
 Solution to many water and environment related issues are directly related to GIS information. Like flooding, erosion, deposition, salinity, etc.
 Presentation of civil





How I used GIS for my purposes





























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Exogenous grid runoff (from upstream), 10**6 m3/y







Grid total VW import, 1000 m3/y (0.5 deg. grid)





Unequal temporal distribution of water

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Monthly Agricultural Water Requirement

[10⁶ m³/0.5°grid cell]

EPIC-2 210° 180° 240° 270° 120° 300° 330° 0° 30° 60° 90° 150° 60° 30° 0° -30° and a -60° 0.2 0.5 1.0 2.0 5.0 10.0 20.0 50.0 100.0 200.0 0.0

Demand doesn't match supply in time

198712

Results



Note that H, E & V do not affect R equally.

We assign weightages for these 3 elements as such:

<u>R = 0.45H * 0.3E *</u> <u>0.25V</u> All weightages were assigned after consultation with various experts, review of available literature, and the researchers' own judgement.







Components of H, E, V & C

Exposure	Weight
Population Density	30%
Land Elevation	20%
Distance from Coast/Sea	20%
Forest/Vegetation Cover	15%
Housing Type	15%
Vulnerability	Weight
Poverty	25%
Income Level	15%
Education	15%
Household Size	5%
Dependency Ratio	10%
Gender (Female Literacy)	5%
Female-to-Male Ratio	3%
Disabled People	2%
Kacha and Semi-Pacca Ratio	20%

Hazard	Weight
Cyclone Frequency	33.33%
Cyclone Wind Speed	33.33%
Cyclone Surge Height	33.33%
Capacity	Weight
Cyclone Shelter Density	25%
Cyclone Shelter Capacity	25%
Pacca Housing	15%
Embankment Length	10%
Road Density	10%
Medical Centers	5%
Growth Centers	5%
Rural Market	5%

Note:

Pacca House: Made of concrete, brick, timber, etc. *Kacha* House: Made of mud, straw bamboo, etc. Semi-Pacca House: Concrete/brick walls with tin roof

Results





$\underline{\mathbf{R}}_{\mathsf{M}} = \mathbf{R} - \mathbf{C}$

We identified that *upazilas* with high risk even after mitigation are at highest need for capacity building. Thus, we introduce the term **Need** henceforth.









Remote sensing and GIS use to identify water quality : Salinity level



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Figure: Map showing the location of Dhaleshwari river (Hasan et a2.62020)

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THANK YOU.