Ecosystem-based Disaster Risk Reduction (Eco-DRR)
Technical Report - GeoAI, Remote Sensing & DRR Modeling

Executive Summary

This report presents a comprehensive Eco-DRR workflow built using Google Earth Engine (GEE), geospatial AI (U-Net segmentation), hydrological modeling, NDVI-based ecosystem condition analysis, and multi-criteria risk fusion.

The approach aligns with the UNEP Eco-DRR Source Book (2019) and supports data-driven planning for Nature-based Solutions (NbS).

EcoDRR GeoAI Workflow

1. **Sentinel-2 preprocessing** – Cloud and shadow masking, NDVI/NDWI.
2. **Local TIFF preparation** – Downsampling and cropping for ML readiness.
3. **Patch extraction –** 32×32 tiles for U-Net.
4. **U-Net segmentation** – Vegetation, bare soil, impervious surface mapping.
5. **DEM hazard modeling** – Slope, depressions, flood susceptibility using NASADEM.
6. **CN runoff modeling** – Rainfall-runoff using CHIRPS rainfall and CN values.
7. **NDVI change detection** – Ecological degradation/restoration analysis.
8. **Habitat quality proxy** – NDVI-based ecosystem service capacity estimation.
9. **DRR risk fusion** – Hazard × Exposure × Vulnerability × Ecosystem Services.

Interpretation of Outputs

- Landcover segmentation shows exposure: built-up = high exposure, vegetation = buffers.
- Flood susceptibility maps low-lying depressions with high water accumulation potential.
- CN runoff highlights hydrological vulnerability driven by impervious surfaces.
- NDVI Δ reveals degradation hotspots that increase vulnerability.
- Habitat quality identifies zones providing stabilizing ecosystem services.
- The DRR risk map fuses all layers to highlight NbS intervention priority sites.

Alignment with UNEP Eco-DRR Source Book

The workflow meets the Source Book's requirements:

- Ecosystem mapping (landcover, NDVI).
- Condition assessment (NDVI Δ, habitat quality).
- Hazard identification (DEM flood proxy, runoff).
- Exposure mapping (built-up areas).
- Vulnerability assessment (ecological degradation).
- Ecosystem services quantification (vegetation, habitat quality).
- Integrated DRR modeling (risk fusion).

Conclusions and Recommendations

The EcoDRR GeoAI workflow provides an effective foundation for spatial resilience planning. It identifies ecological degradation, hydrological hazards, and priority NbS zones.

Future steps include:

- Integration with full InVEST models.
- Adding socioeconomic vulnerability data.
- Climate scenario modeling for long-term planning.
- Developing an EcoDRR dashboard for decision-makers.