# Tblisi Flood 2015

## Initial findings and recommendations

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# Emergency Assessment Process

- Site Assessment
  - Field review of Vere River watershed
- Storm Damage Assessment
- Understanding Values
- Future Threats Assessment
- Response Actions
  - Immediate – Mid-term – Long-term
  - Tool Box

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# Approach to understanding watersheds

- Inherent Characteristics
  - Inherent geology/geomorphology/soils
  - Climatic drivers
  - Stream channel geomorphic characteristics
  - Vegetation patterns

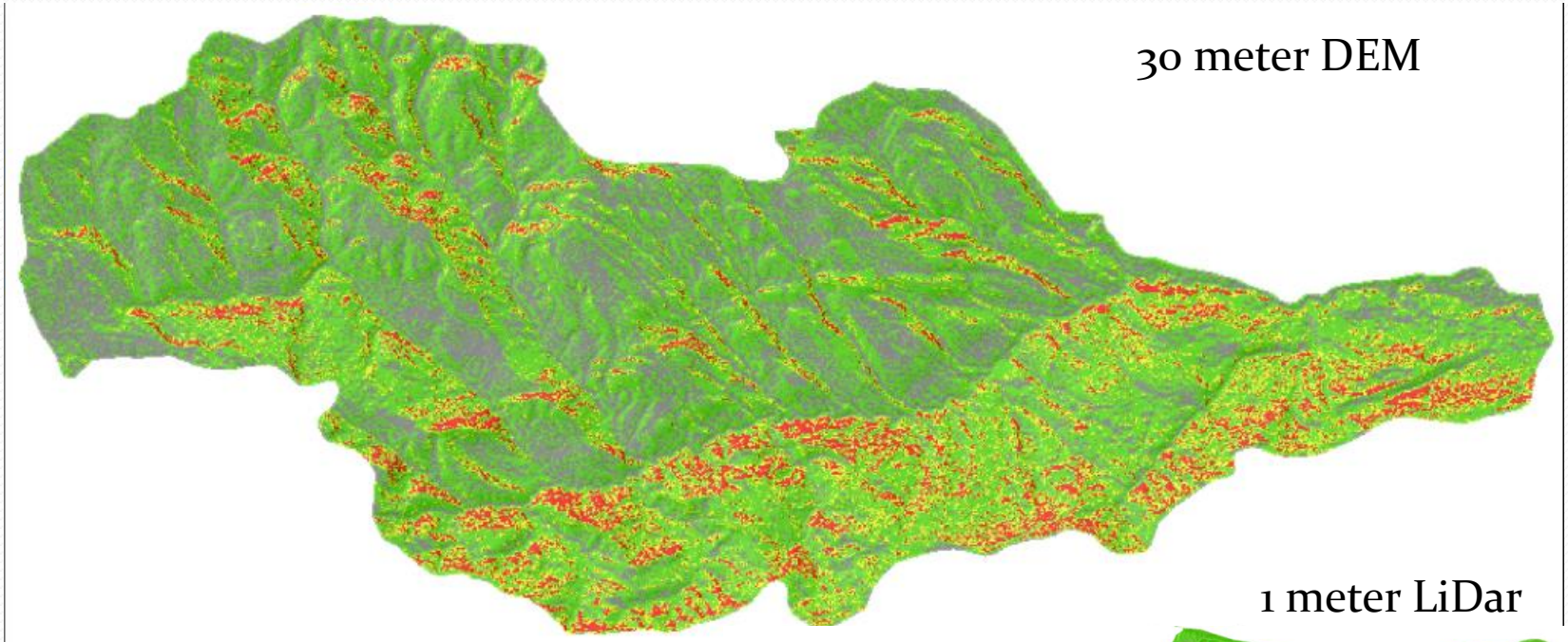
- Human Influences/Alterations
  - Roads,
  - Infrastructure: housing, facilities,
  - Landuse (alterations of native ecosystems)

# Geology

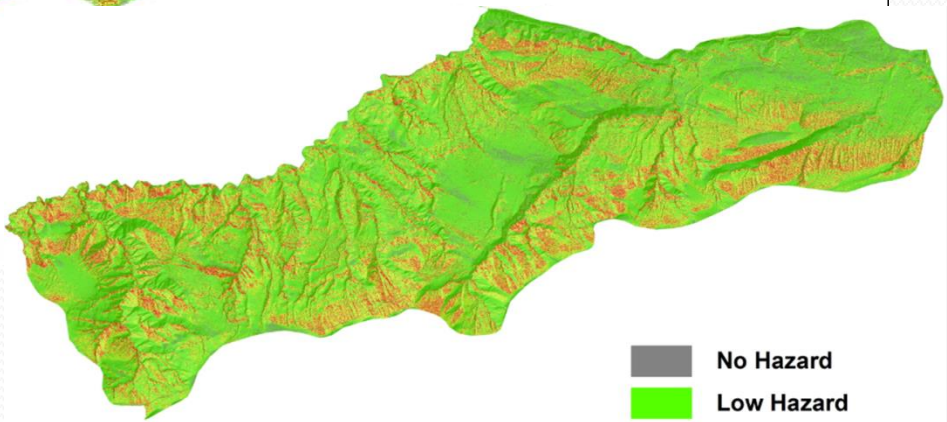
## Fragile Bedrock

## Layers Parallel Slope

# Preliminary Landslide Risk Map




No Hazard
Low Hazard
Moderate Hazard
High Hazard

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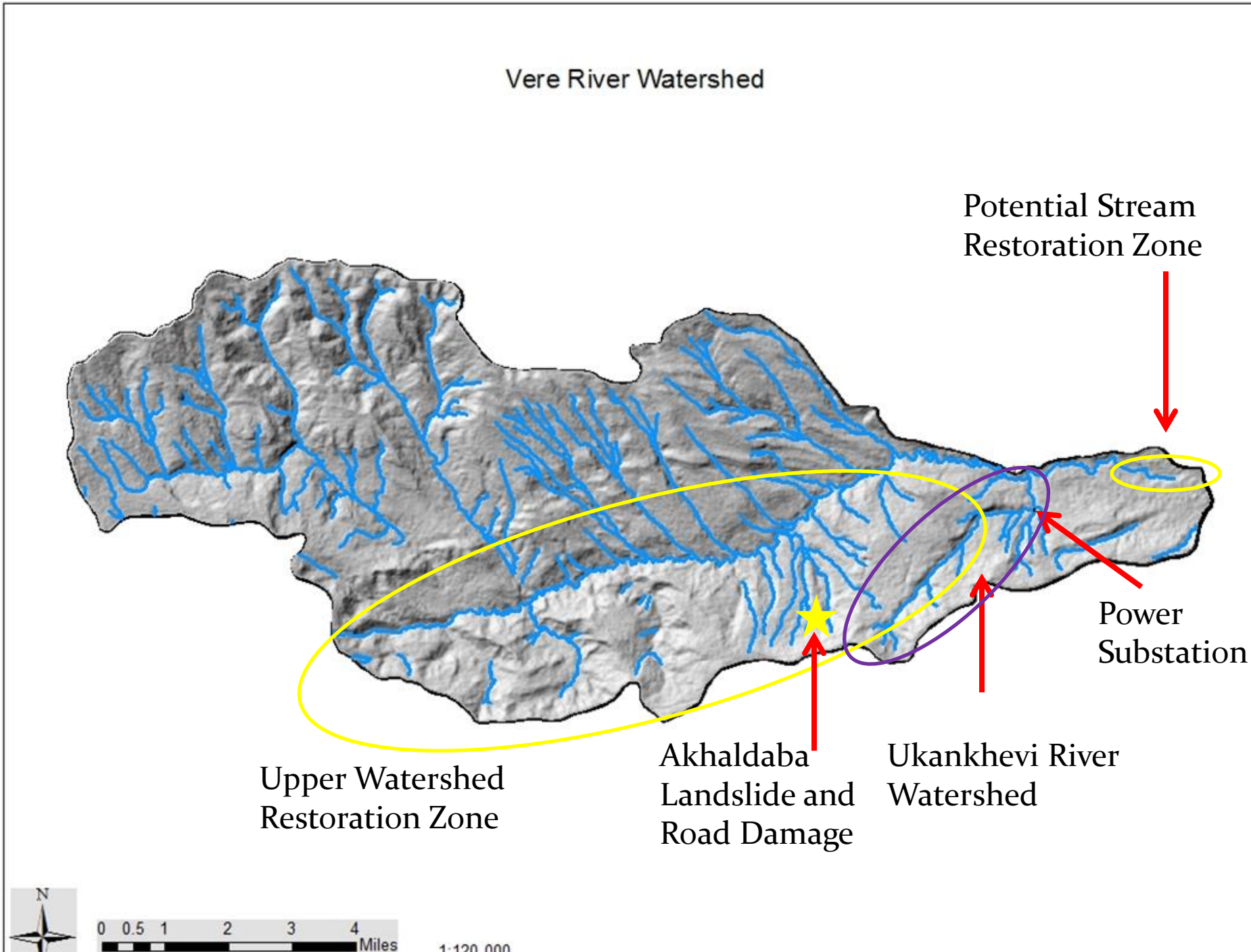
# Dynamic Stream Channel

- Confined valley form limits flood plain development
- High sinuosity (natural energy dissipation)
  - Driven by geology
  - Natural down-cutting and erosion of outer meander
- Braided stream channel – excess sediment


Vere River Watershed
Potential Stream Restoration Zone
Power Substation
Upper Watershed Restoration Zone
Akhaldaba Landslide and Road Damage
Ukankhevi River Watershed
N
0 0.5 1 2 3 4
Miles
1:120,000

# Storm Impact Assessment

- Tiblisi City

  - Tunnels/Culverts -
    - blocking/accelerating flows
    - Inundation
    - Deposition/Scour
    - Backwater at Mtkvari

  - Infrastructure Loss
    - Housing, Roads
    - Utility - power, sewer, water supply
    - Zoo

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# Storm Impact Assessment

- Upper Watershed
  - Storm flow from headwaters
  - Multiple landslides (100 s)
  - Loss/erosion of roads/housing
  - Heavy sediment loads , bedload moving high in water column
  - Landslides bulked flow, temporarily backed up mainstem
  - Streamside trees stored debris

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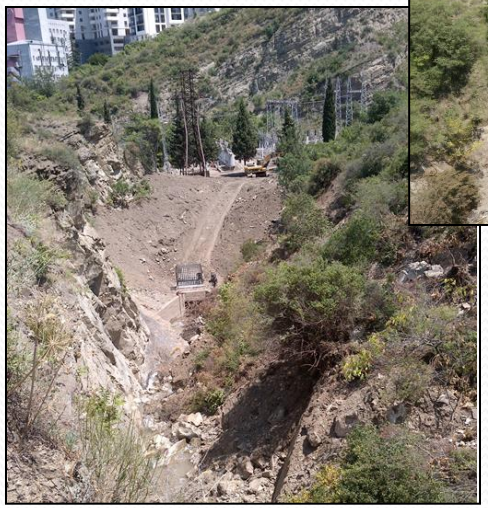
# Storm Damage Assessment

- UkanKhevi River
  - Sediment blocked culvert => infrastructure
  - Earthflow
  - Rockslide / channel blockage
  - Piping within electricity sub-station facility



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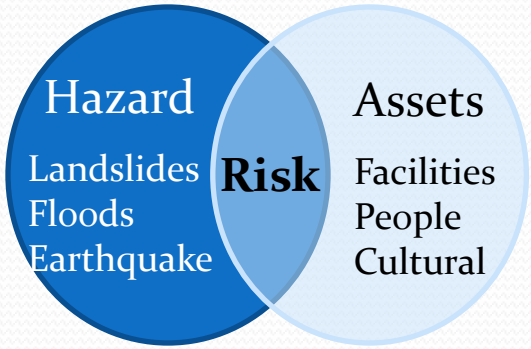
# Understanding Values

- Human life and safety
- Property
- Access needs
- Sustainable Infrastructure
- Cultural Resources

# On-going Threats/Risks

- Landslides
  - Scour potential
  - River blocking potential => dambreak floods
  - Sediment loading
- Floods
- Earthquakes
- Human encroachment on streams and unstable areas




Be Aware and Prepare

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# Prioritization of Actions

| Probability of Damage or Loss | Magnitude of Consequences | | |
|---|---|---|---|
| | Major | Moderate | Minor |
| | RISK | | |
| Very Likely | **Very High** | **Very High** | **Low** |
| Likely | **Very High** | **High** | **Low** |
| Possible | **High** | **Intermediate** | **Low** |
| Unlikely | **Intermediate** | **Low** | **Very Low** |

**Probability of Damage or Loss:** The following descriptions provide a framework to estimate the relative probability that damage or loss would occur within 1 to 3 years (depending on the resource):

- Very likely. Nearly certain occurrence (90% - 100%))
- Likely. Likely occurrence (50% - 89%)
- Possible. Possible occurrence (10% - 49%)
- Unlikely. Unlikely occurrence (0% - 9%)

# Action/Risk Response Table

| Recommendation | Probability of damage or loss without recommendation | Magnitude of Consequences | Risk Reduction Rating | Pros | Cons |
|---|---|---|---|---|---|
| Streamside Management Zone (SMZ) | Very High | Major | High- threat to life and property removed | Can be rapidly developed, low potential for failure | Displacement of existing homes, businesses, and other infrastructure; cost of relocation |
| Vere River restoration in Tbilisi | High | Major | Moderate: some flooding | Natural stream function | High cost; displacement of existing |

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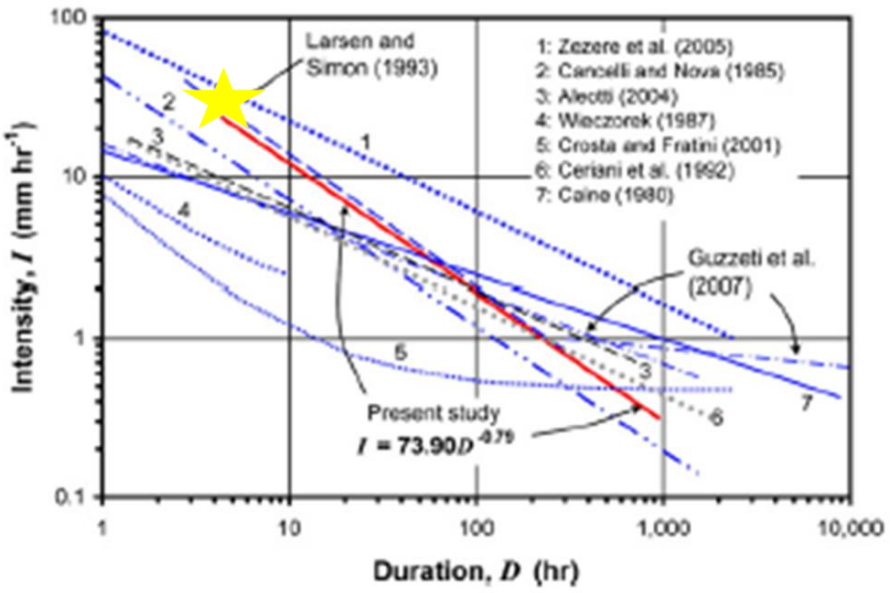
# Immediate Response Actions

- Have a comprehensive plan!
- Establish an early warning system (precip, streamflow, landslide) with notification
- Establish and enforce policy to regulate streamside development
- Establish road standards and a permitting system
- Develop a site specific landslide risk map, warn communities/individuals of impending risk




Source: Dahal 2014

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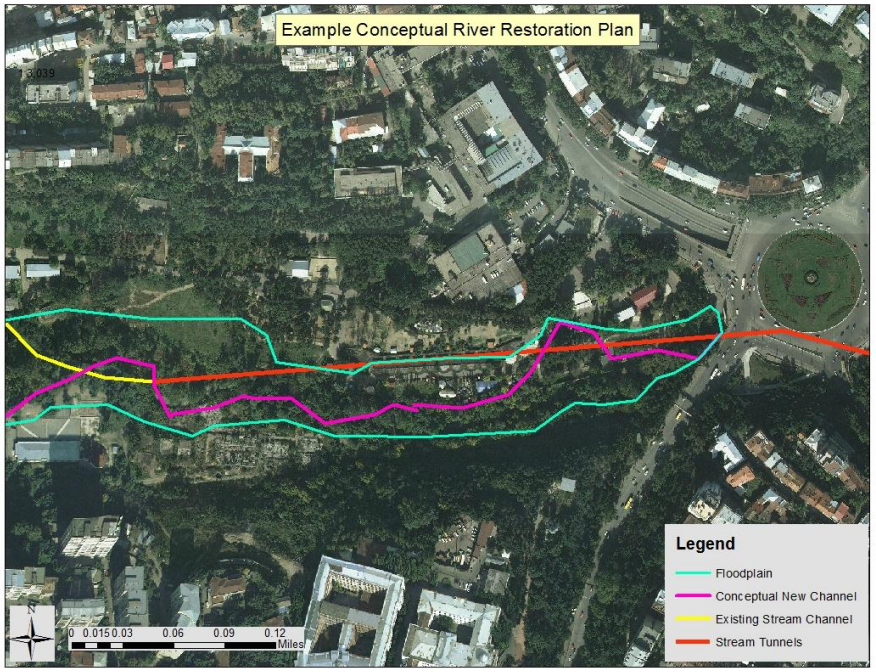
# Immediate Response Actions

- Tblisi City
  - Determine support for restoring natural stream function
    - Prepare holistic design for restoration of green corridor
  - Disconnect water and sewage system




Up to 50% of the mainstem Vere River is in tunnels through the city

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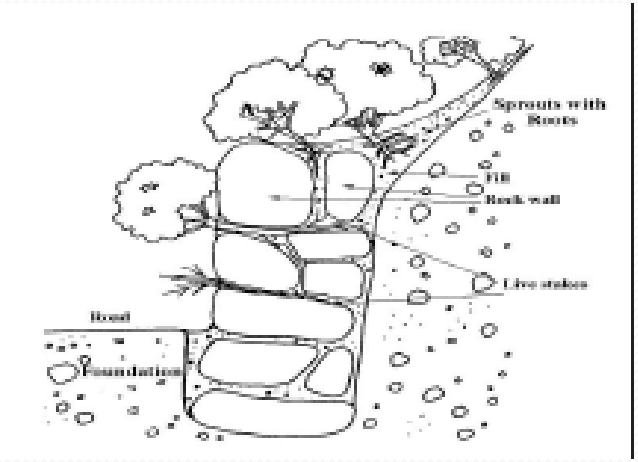
# Immediate Response Actions

- Ukankhevi River
  - Remove rockfall blocking river, clear from top down
  - Stabilize earthflow
  - Check headward erosion
  - Protect existing infrastructure
    - Electricity Sub-station




# Immediate Response Actions

- Upper Watershed
  - Close  main Hwy Tskneti Hwy - establish alternate route
  - Assess stability of Akhaldaba landslide and adjacent area
    - Remove hazards
    - Consider threats to community /lower road
    - Consider alternate access route
  - Use sustainable and safe construction techniques even for temporary fixes (BMPs)
  - Install drainage on road system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# Mid->Long-Term Response Actions

- Tblisi City
  - Determine maximum probable floods
    - size remaining culvert or install bridges to pass water, sediment and debris
    - Allow river/floodplain access
  - Create holistic design for stream corridor restoration
  - Implement stream restoration plan

- Ukankhevi River
  - Develop plan to move or protect or move the electric sub-station

- Upper Watershed
  - Land use planning and zoning regulated and enforced
  - Reestablish native forests, protect them from grazing
  - Undertake comprehensive road management planning

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# Conclusions

- Opportunity to plan for the future you want, develop comprehensive plans
- Institute legislation to regulate development and growth – protect streams
- Use green infrastructure to restore watershed conditions and reduce peak storm flows in the watershed

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# Discussion and Feedback


2015
2010
2009

# Assets at Risk

- Infrastructure in the stream channel
  - Roads, Culverts, Houses, Cemeteries, Zoo
  - Utilities
    - Electricity substation
    - Water Supply
    - Sewage
  - New Road, Land-bridge, Zoo,
- Housing and infrastructure  within landslide zones
- Sustainable roads systems
  - Construction techniques and road drainage