

Preparing Small-Scale Hydropower Projects for Private Sector Participation

Consulting Services to Government of Tajikistan

Presentation of the current findings

GISCA'11 Almaty / Kazakhstan

Authors:

- Ernst Basler & Partner
- ITECO
- Geoldee.ch



Geoldee.ch



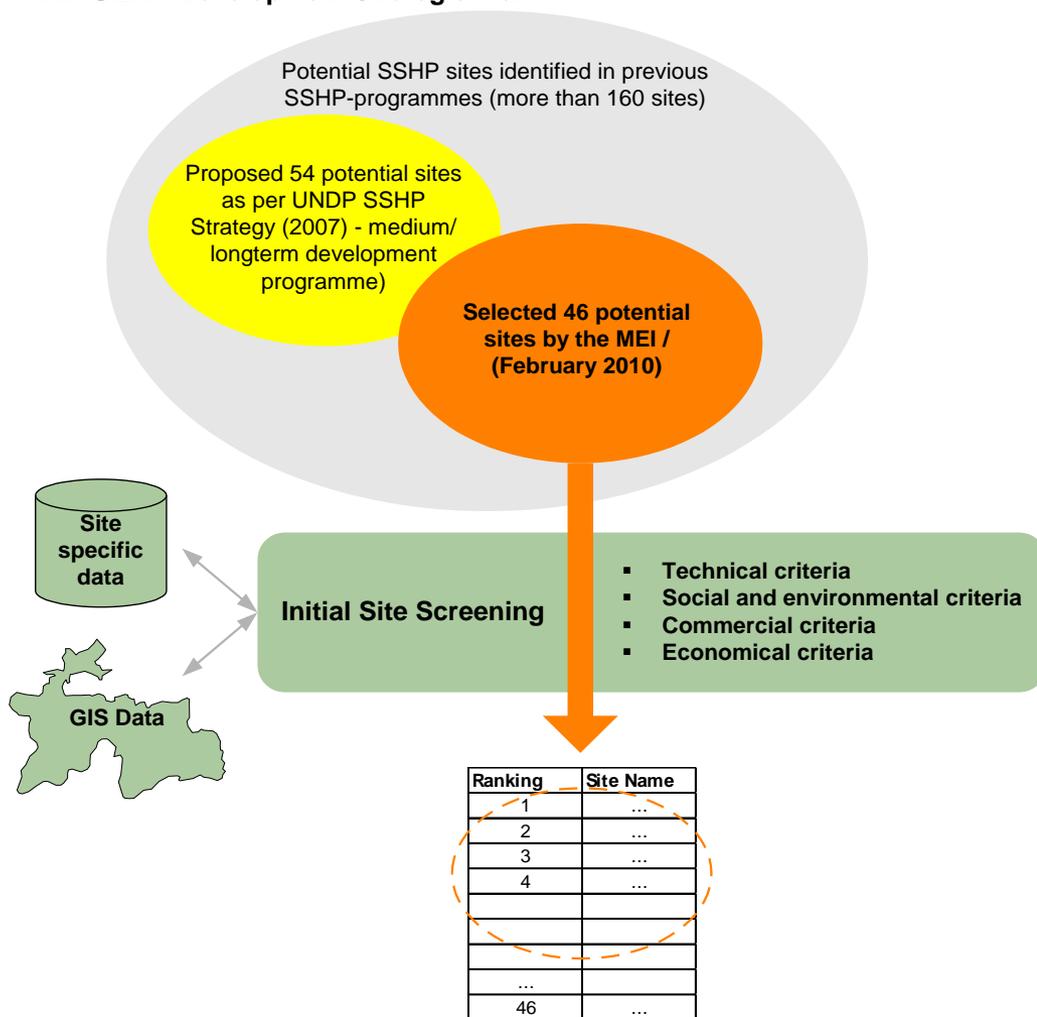
Ernst Basler + Partner

Agenda

- Introduction development strategic plan
- Selection criteria for small scale hydropower station (SSHP)
- Screening sites
- Site-Database and Geo-Database
- Hydrology, Electrical Grid and Protected Areas
- Geoprocessing and –analysis
- Evaluation Matrix
- Limitations and Benefits of GIS

Introduction - Development Strategic Plan

PHASE I - Development Strategic Plan



- Data collection for 46 sites (sites proposed by MEI)
- Transparent assessment and ranking
- Selection of 33 sites for further specification (Phase II) and subsequent tendering (min. 20 sites)

Selection Criteria I/II

Economical criteria

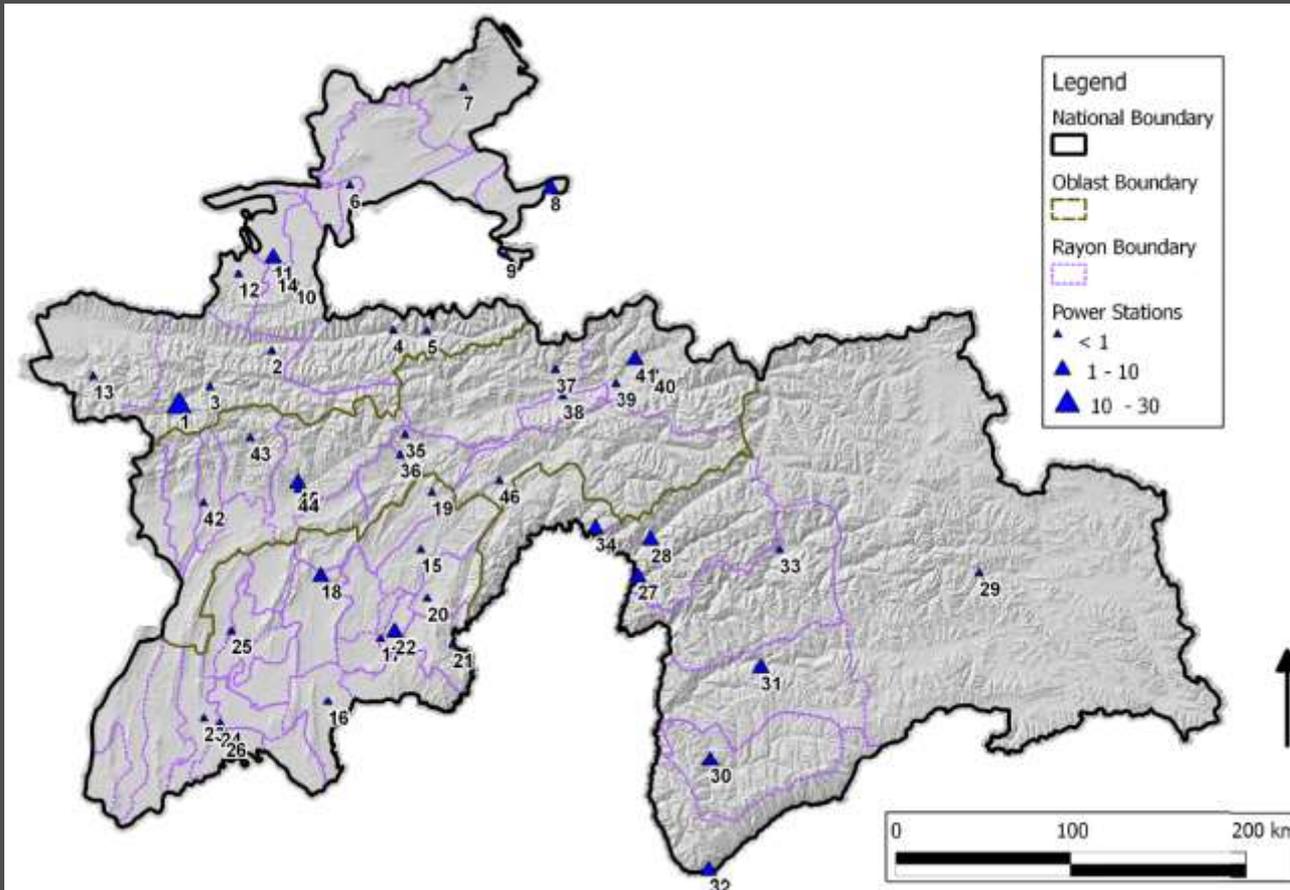
- Power = Economy of Scale
- Gradient (Head) = Economy of Density of Resource
- Geology, Natural Hazard, etc.
- Length of Feed-in Line (Distance to high tension grid)
As far as available for selection
- Distance to next transport road
- Synergies and conflicts with other (water-) infrastructures

Selection Criteria II/II

Qualitative criteria

- Risks (Natural hazards, hydrology, data accuracy, ...)
- Climate change risks
- Social impact
 - Considered positive and negative impact
- Ecological impact
 - Fish migration
 - Reserved flow (riparian flow)
 - Landscape
- ...

Screening Sites



Category	Nr. of sites
< 1MW	29
1 -10 MW	15
10 – 30 MW	2
Reconstruction	1 (< 1 MW) 3 (1-10 MW)

Small Hydropower – Site Database

- Collection of site specific data (Access-Database)
- Technical scheme data
- Site conditions
- Site hydrology
- Site access (grid, road)
- Environmental and social impact

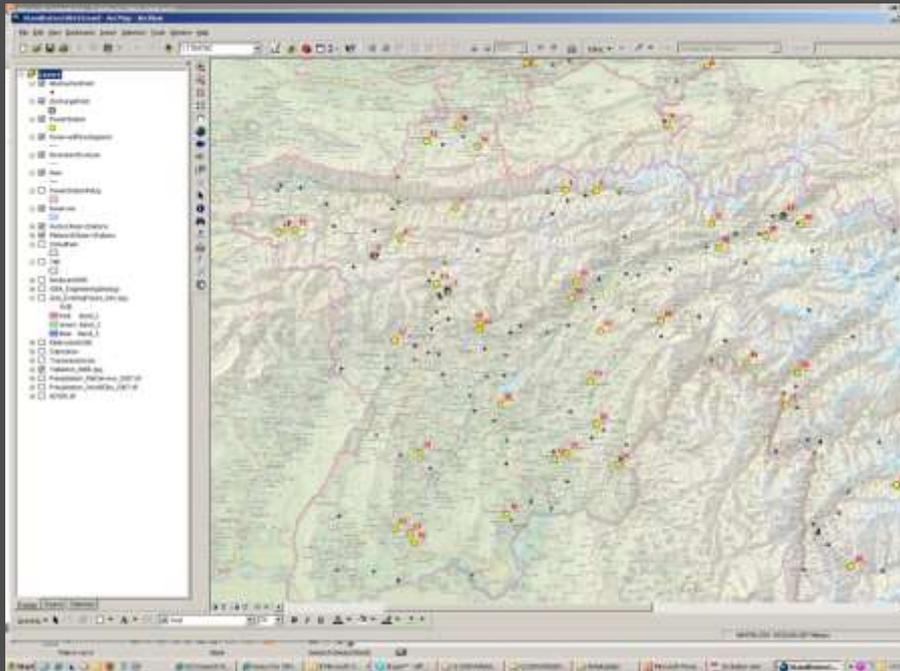
ID	Name	Location	Capacity (kW)	Year	Status	Notes
1	Alp	Alp	10	2000	Operational	
2	Alp	Alp	10	2000	Operational	
3	Alp	Alp	10	2000	Operational	
4	Alp	Alp	10	2000	Operational	
5	Alp	Alp	10	2000	Operational	
6	Alp	Alp	10	2000	Operational	
7	Alp	Alp	10	2000	Operational	
8	Alp	Alp	10	2000	Operational	
9	Alp	Alp	10	2000	Operational	
10	Alp	Alp	10	2000	Operational	
11	Alp	Alp	10	2000	Operational	
12	Alp	Alp	10	2000	Operational	
13	Alp	Alp	10	2000	Operational	
14	Alp	Alp	10	2000	Operational	
15	Alp	Alp	10	2000	Operational	
16	Alp	Alp	10	2000	Operational	
17	Alp	Alp	10	2000	Operational	
18	Alp	Alp	10	2000	Operational	
19	Alp	Alp	10	2000	Operational	
20	Alp	Alp	10	2000	Operational	
21	Alp	Alp	10	2000	Operational	
22	Alp	Alp	10	2000	Operational	
23	Alp	Alp	10	2000	Operational	
24	Alp	Alp	10	2000	Operational	
25	Alp	Alp	10	2000	Operational	
26	Alp	Alp	10	2000	Operational	
27	Alp	Alp	10	2000	Operational	
28	Alp	Alp	10	2000	Operational	
29	Alp	Alp	10	2000	Operational	
30	Alp	Alp	10	2000	Operational	

Issues/ Remarks

- Desk work
- No onsite-data collection in this phase
- Limited data availability

Small Hydropower – GIS I/III

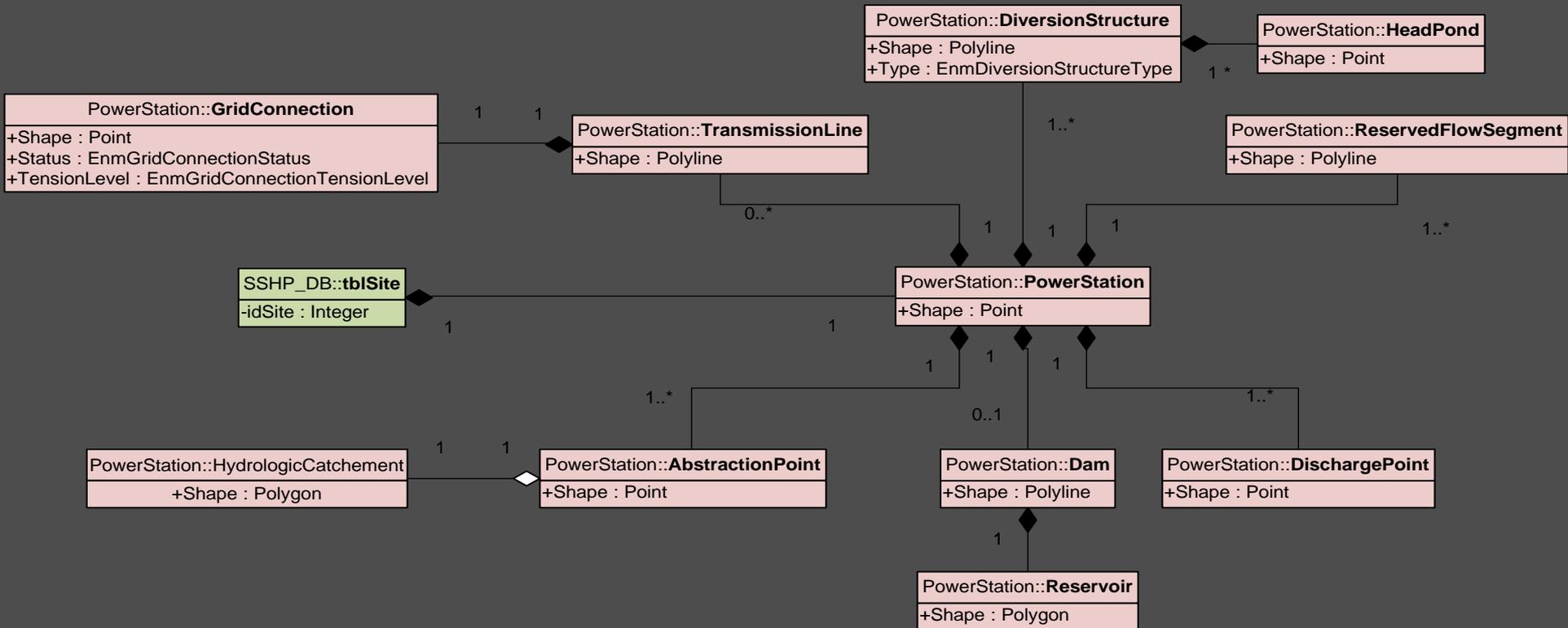
- Collection of available GIS-data
- Digitalization of analog data
- Simple Modeling
- Topographic basemaps
- Digital elevation model (ASTER)
- Electrical Grid-Data
- Various geographical mapsets
- Sociological data
- ...
- -> Open system for further data



Issues

- No central data host
- Restricted access to official data
- Limited digital data availability – e.g. El. Grid only on paper!

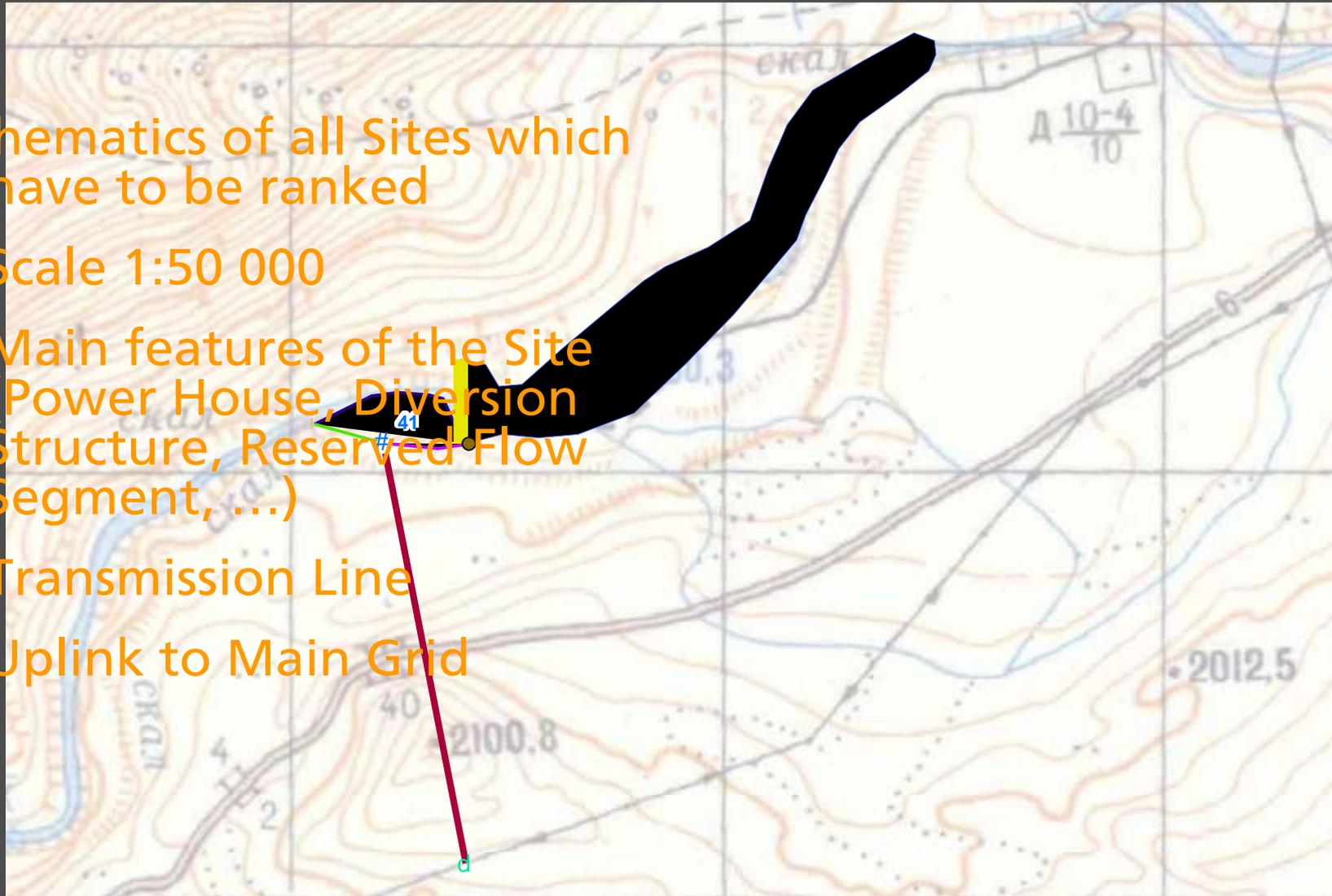
Small Hydropower – GIS II/II



Small Hydropower – GIS III/III

Schematics of all Sites which have to be ranked

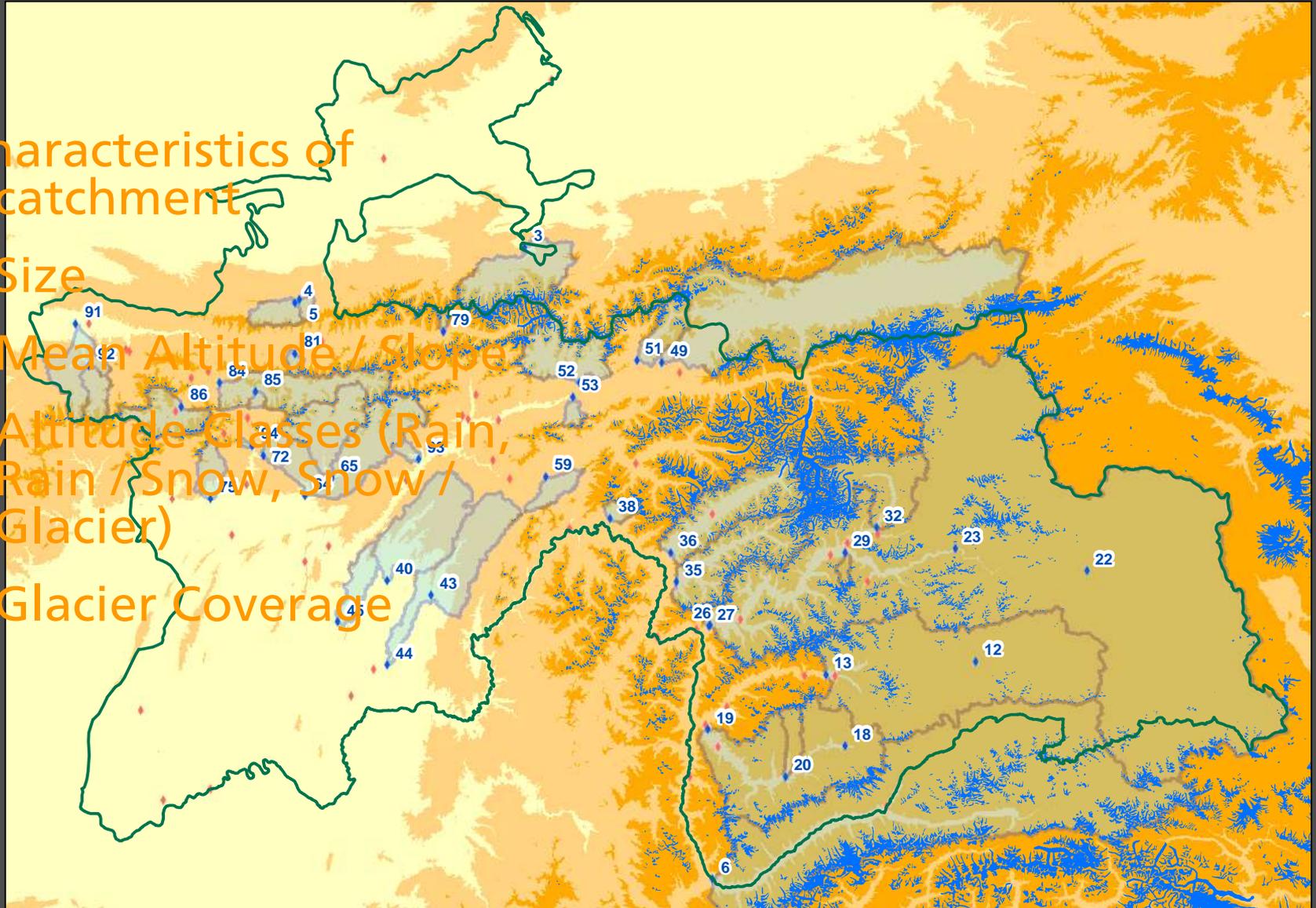
- Scale 1:50 000
- Main features of the Site (Power House, Diversion Structure, Reserved Flow Segment, ...)
- Transmission Line
- Uplink to Main Grid



Hydrology I/II

Characteristics of catchment

- Size
- Mean Altitude / Slope
- Altitude Classes (Rain, Rain / Snow, Snow / Glacier)
- Glacier Coverage



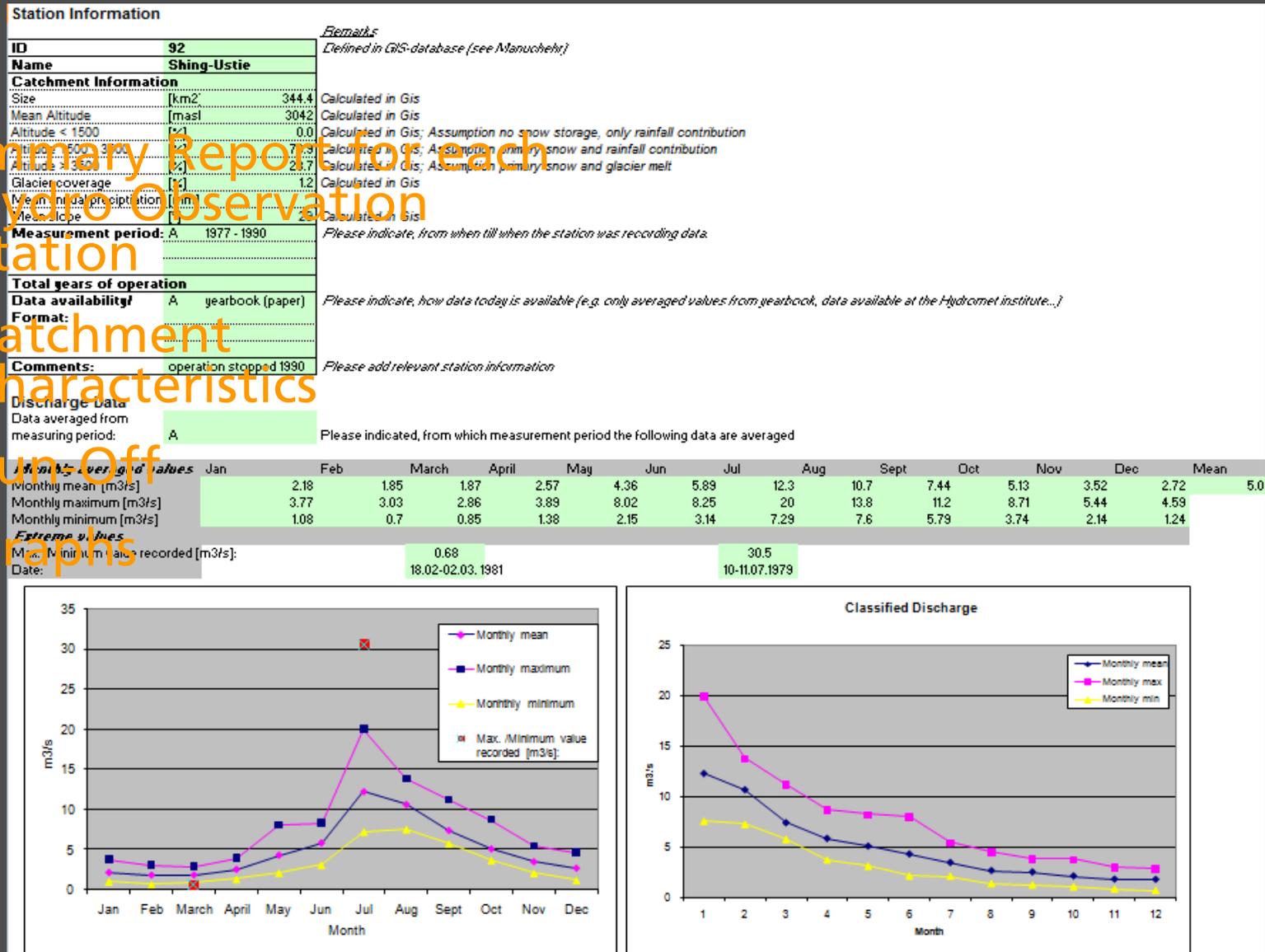
Hydrology I/II

Summary Report for each Hydro Observation Station

Catchment Characteristics

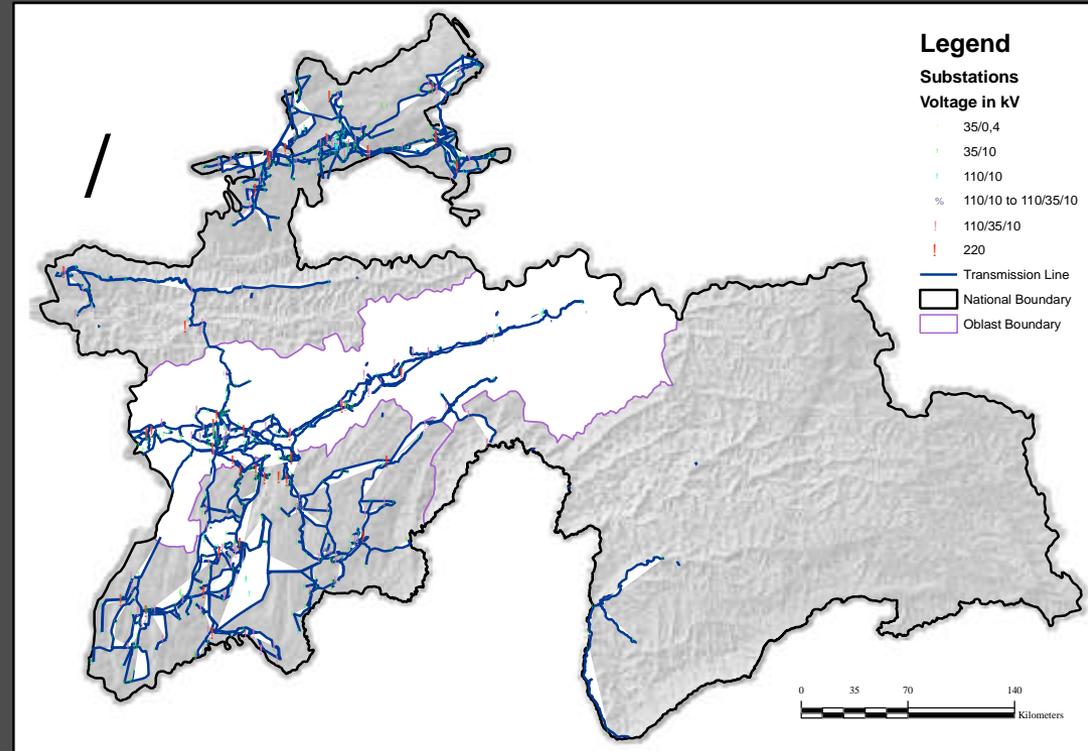
Run Off

Graphs



Electrical Grid

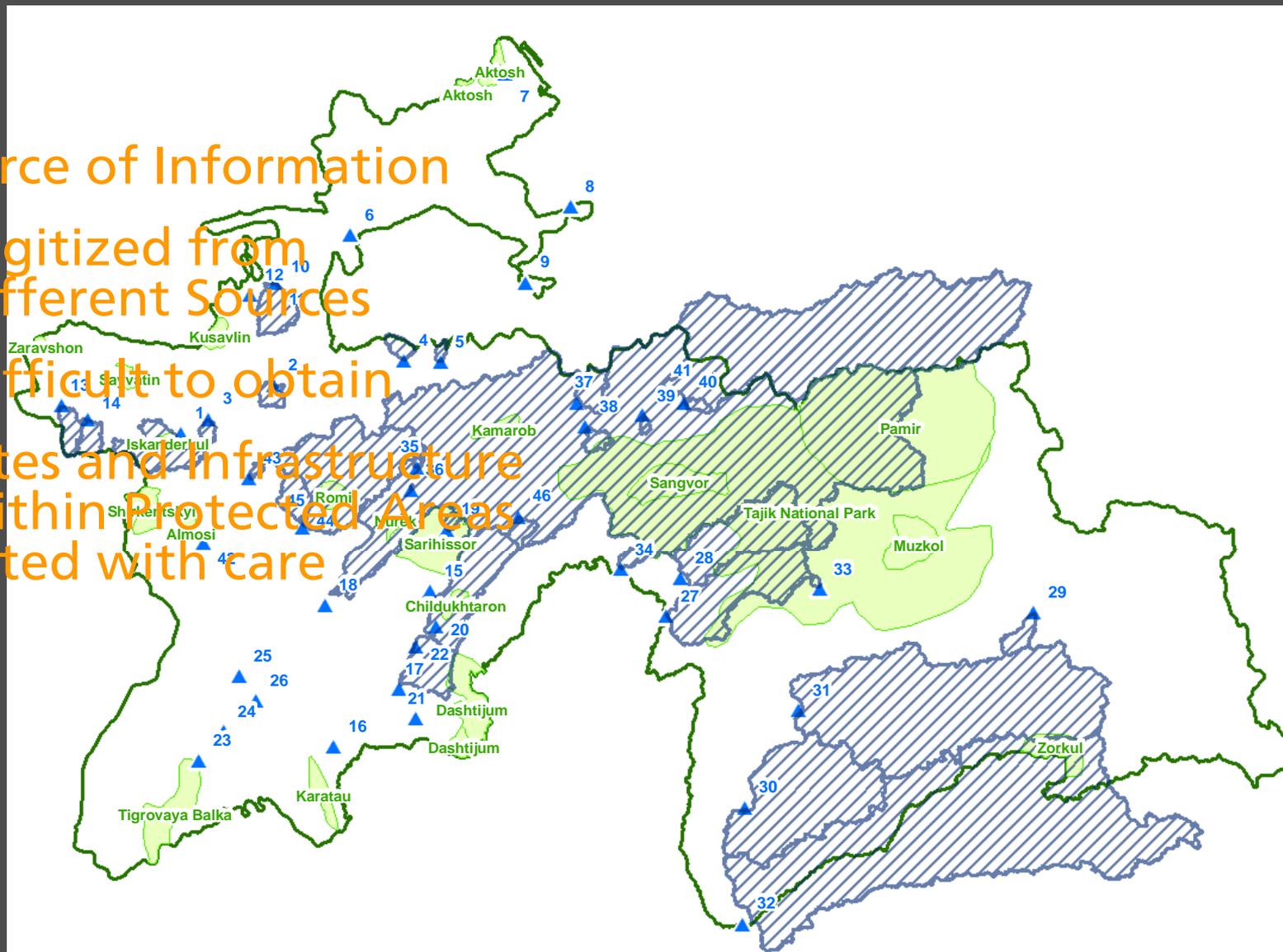
- Digitized from schematic layouts
- Existing Power Stations
- Substation, Transformers
- Transmission Lines (High Voltage, Medium Voltage)
- Partly uplink of SSHP



Protected Areas

Source of Information

- Digitized from different Sources
- Difficult to obtain
- Sites and Infrastructure within Protected Areas rated with care



Geoprocessing and –analysis I/II

```

print "----- Start Site " + str(iStationID) + "-----"

# Test if the table already exists. If yes, no statistic will be calculated
if gp.Exists(strOutputTable):
    print "-> Statistics on altitude of site " + str(iStationID) + " is already calculated"

# Table not existing yet. Statistics will be calculated
else:
    try:
        # Export of the watershed for a single site
        print "- Export watershed, ID: " + str(iStationID)
        strExportFile = r"C:\Temp\Temp_Watershed_" + str(iStationID) + ".shp"
        strExportSql = ' "StationID" = ' + str(iStationID)

        # Make sure no files are still in temp folder
        if gp.Exists(strExportFile) == True:
            gp.delete_management(strExportFile)

        # Export the desired watershed
        gp.select_analysis(strInputFile, strExportFile, strExportSql)

        # Calculate the zonal statistics
        print "Zonal statistics, ID: " + str(iStationID)
        if gp.Exists(strOutputTable) == False:
            gp.ZonalStatisticsAsTable_sa (strExportFile, "StationID", strInputRunOffRaster, strOutputTable, "DATA")

        print "-> Site " + str(iStationID) + " successfully completed"

    except:
        print "Unexpected error:", gp.GetMessages()
        print "-> Site " + str(iStationID) + " unsuccessfully completed"

finally:
    # Delete of temporary files
    if gp.Exists(strExportFile):
        print "- Delete of unused files, ID: " + str(iStationID)
        gp.Delete_management (strExportFile)

print "----- End Site " + str(iStationID) + "-----"

```

Geoprocessing

- Compilation of Base Maps
- Derivation of Catchments of Hydropower Station and Hydro Observation Station

➤ Python scripting

Geoanalysis

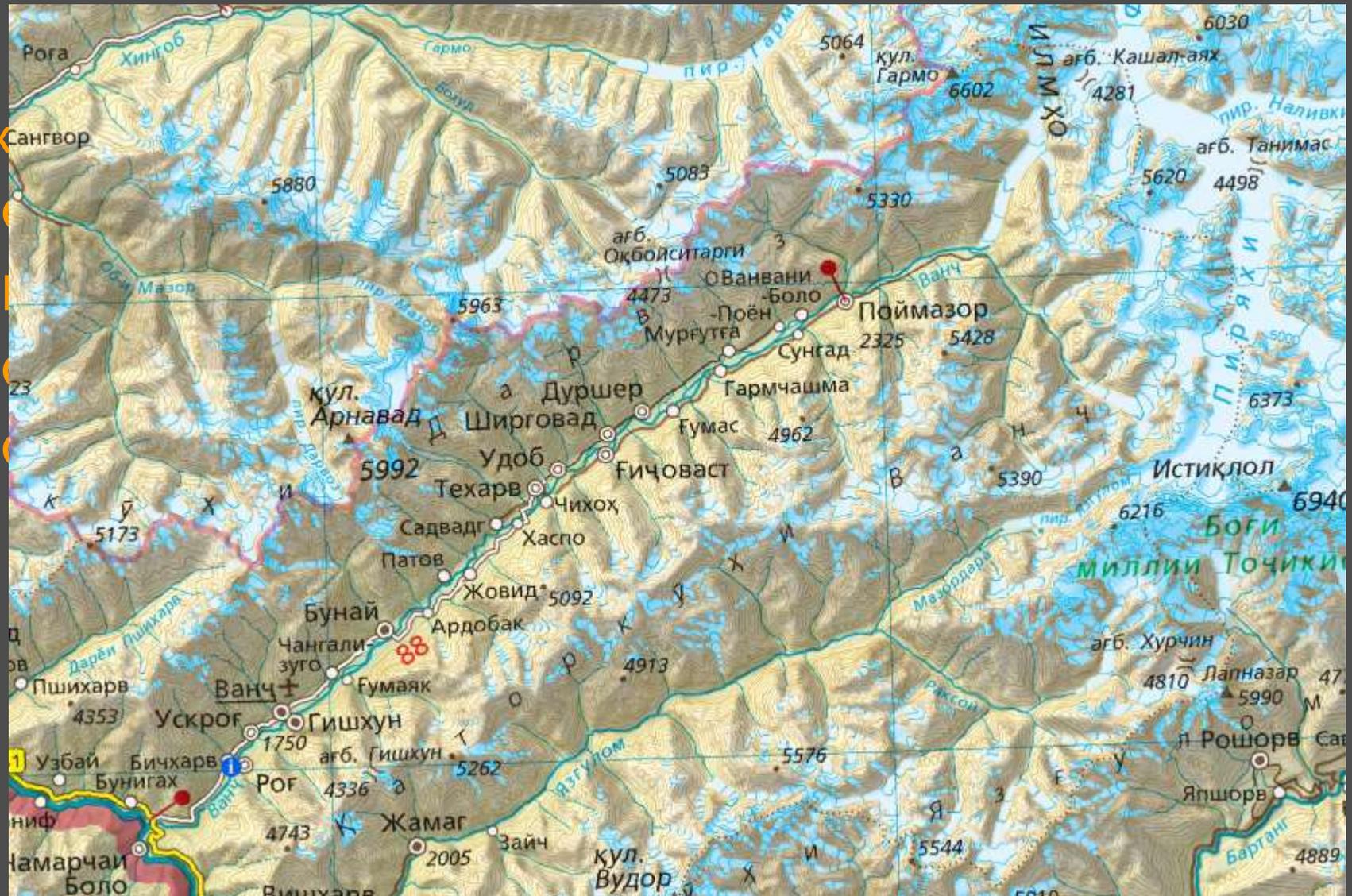
Catchment Characteristics (Altitude, Slope, Aspect, Glacier Coverage)

Local Benefit

Run Off and Precipitation

Geoprocessing and –analysis II/II

Ex



Evaluation Matrix I/II

Rating of all Sites based on the Information in the DB and GIS

- Hydrology and Resulting Power
- Construction
- Geology
- Environmental and Social Impact
- Main Grid Risk
- Other Investor Risks
 - Transparent assessment and ranking

Evaluation Matrix II/II

$$\sum_{j=1}^m \left(\sum_{i=1}^n f_i \right)_j p_j$$

- f* Factor derived from DB and / or GIS
- p* Weight per Group of factors
- i* Number of Factors
- j* Number of Groups of Factors

Limitations of GIS

- Difficult available Data (analog data, ...)
- Uncertain ownership of Data (Government, Ministry, Committee, Agency, Private, ...)
- Legislation and State Secrecy of the Republic of Tajikistan
- Limitation in Spatial Resolution / Scale
- Not updated Base Information (Maps, ...) / Temporal Resolution
- Location of SSHP sites not suitable for GIS analysis (Irrigation channels, ...)

GIS approach – What for / Benefits

Goals

- Optimization of resource harnessing
- Watershed management optimization
- Synergies and conflicts
- Quality and efficiency

Tools

- Exchange of information between experts
- Common database between different projects
- Planning tool
- Public accessible information

