



Parameters for Inflow model setup using AGOL

Trond Ottersland, Powel AS
Water Resources meeting
San Diego 2015-07-19

About me

- Solution Manager at Powel AS, Esri Business Partner and reseller
- Esri user since 1996
- Main focus now: Utilizing GIS in power generation
- Live in the middle of Norway, 600 km north of Oslo



Contents

- Powel Inflow model description
- Getting parameters with ArcGIS and AGOL
- Some examples and results
- Further improvements and work

Sustainable Water Management

Hydropower producer's perspective

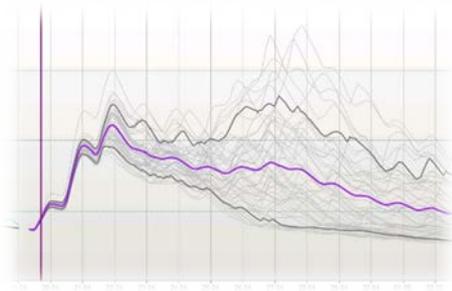
- Maximize profit
- Minimize spill
- Operate inside discharge limits
- Operate inside reservoir level limits
- Minimize flood damages



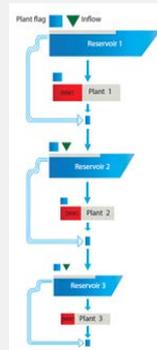
Powel Inflow

- Weather forecasts
- Uncertainty in forecasts
- Seasonal variations
- Different weather regimes

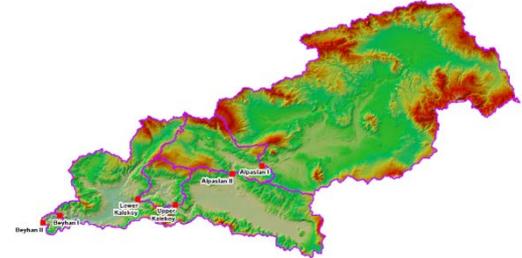
Time delay from precipitation to runoff?



- Size of reservoirs?
- Risk of flooding ?



- Snow conditions
- Ground conditions
- Field responding to historical weather



- Topology and size of catchment area
- Temperature in different altitudes
- Precipitation in different altitudes
- Evaporation

Inflow model, HBV

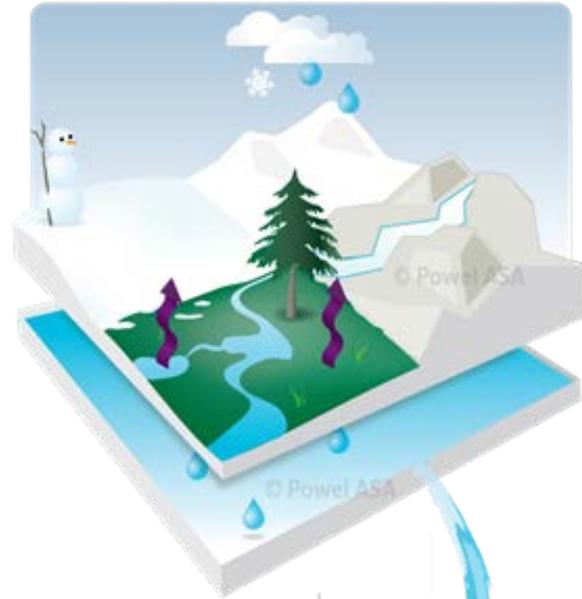


Parameters

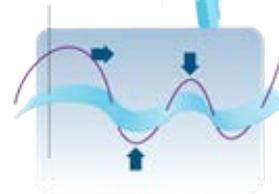
- Hypsography
- Lakes
- Glaciers

Simulation routines

- Snow
- Glacier
- Soil
- Groundwater
- Evaporation



Simulated run-off



Task: Inflow model setup

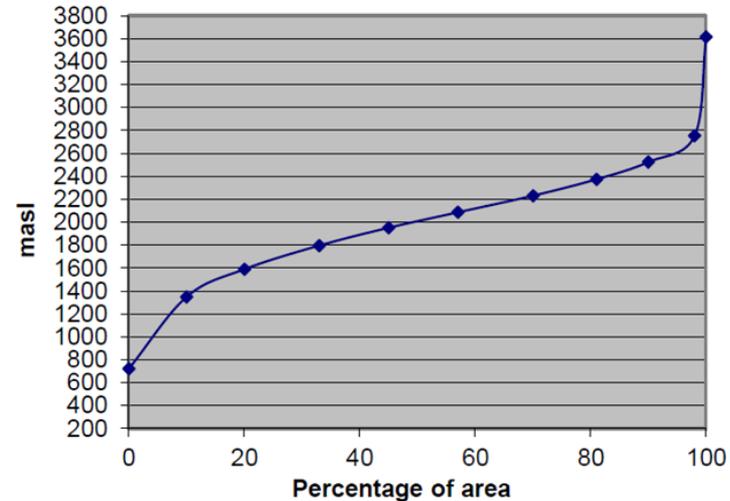
- Requirements: Parameters and historical data
- Auto-calibration routine fine tunes model
- Target $R^2 \geq 0.8$

Need from GIS: Catchment area and hypsographical curve

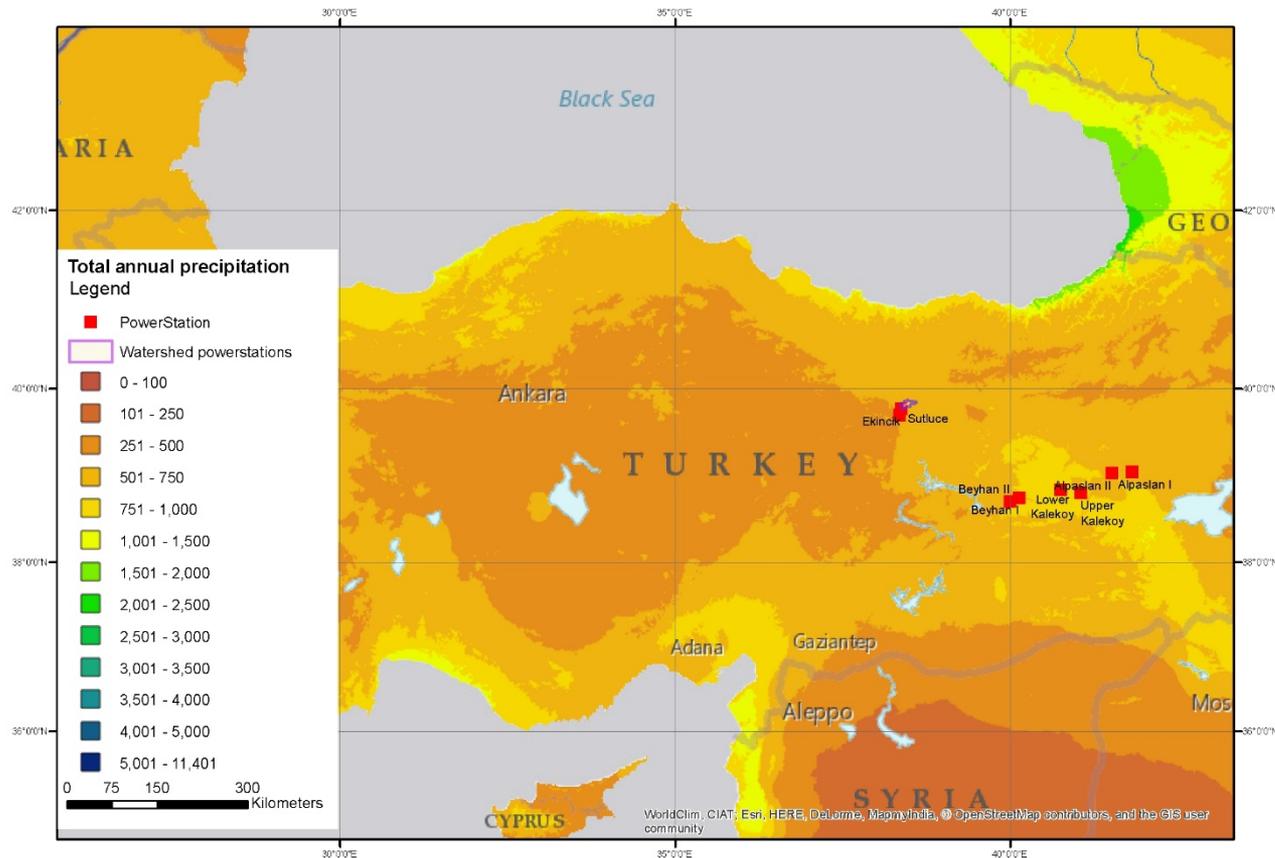
Melado case study, Chile



Hypsographical curve

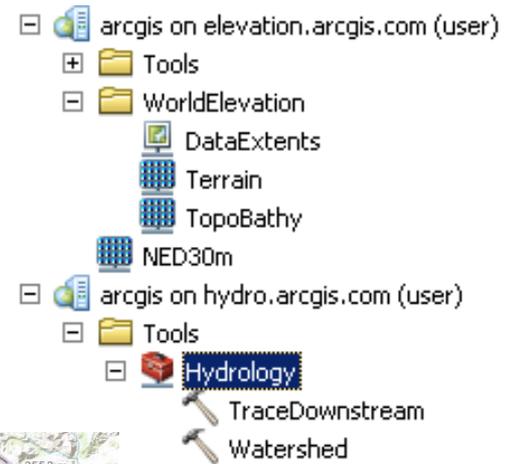
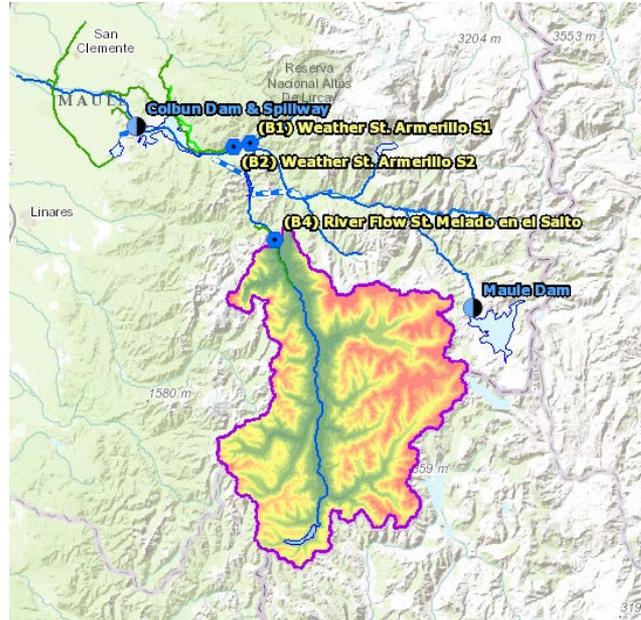


Rainfall distribution

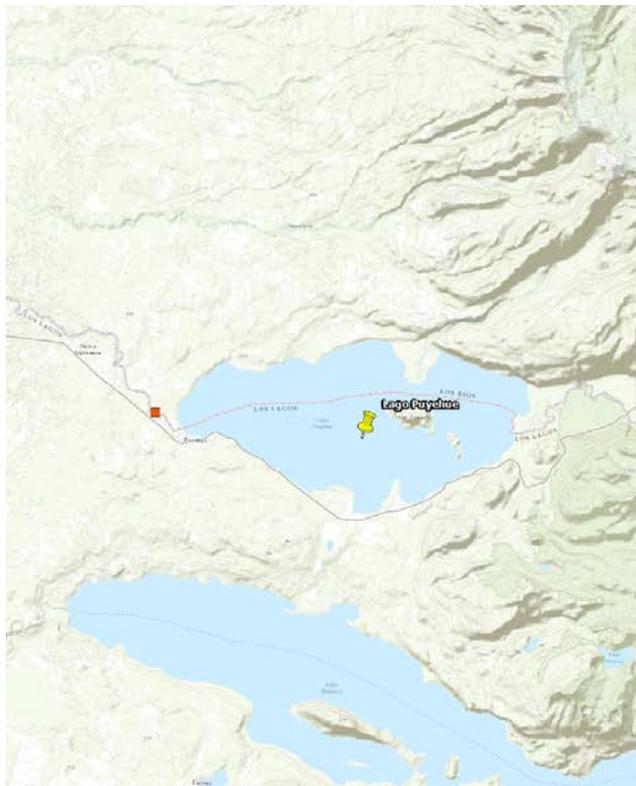


Now: AGOL!

- Worldwide DEM 30m/90m in AGOL
- Watershed delineation service
- Temperature and precipitation datasets as before



Find area



Watershed

Input Points

Watershed::InputPoints

- ◆ InputPoints

Point Identification Field (optional)

Snap Distance (optional)

Snap Distance Units (optional)

Meters

Data Source Resolution (optional)

Generalize Watershed Polygons (optional)

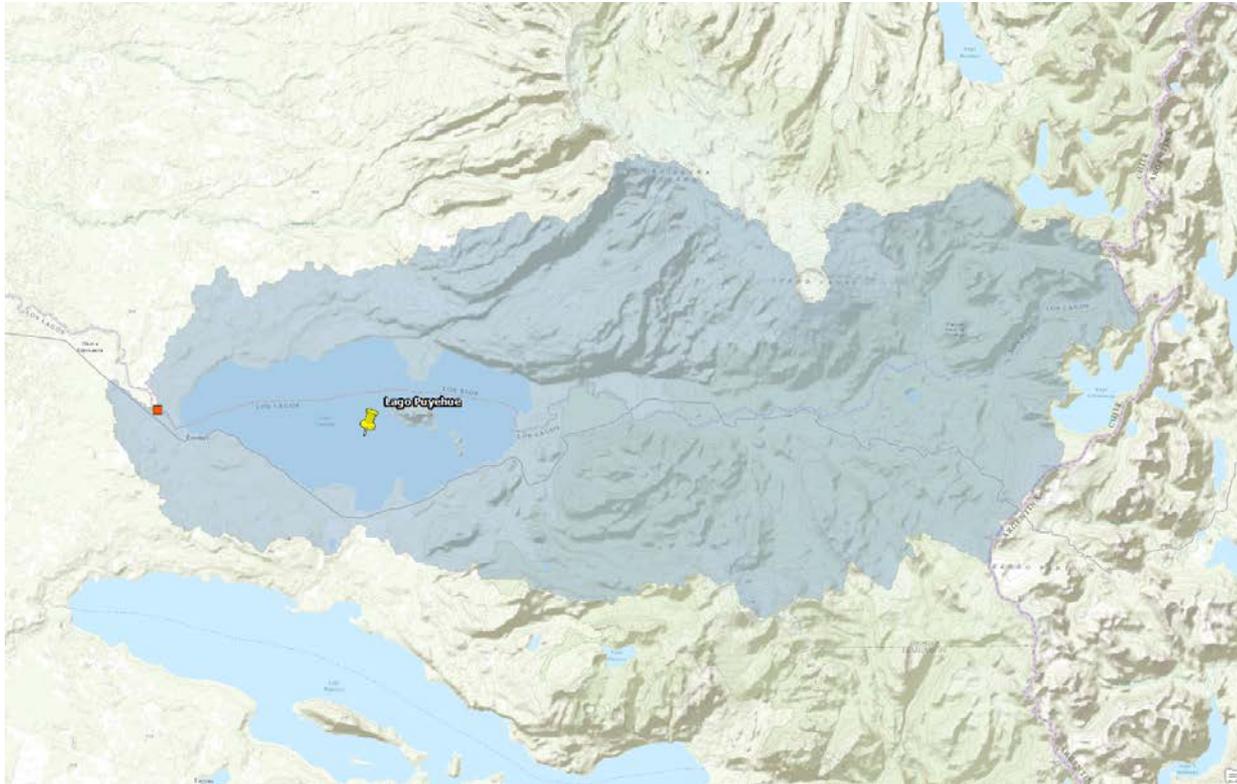
Return Snapped Points (optional)

OK Cancel Environments... << Hide Help Tool Help

Input Points

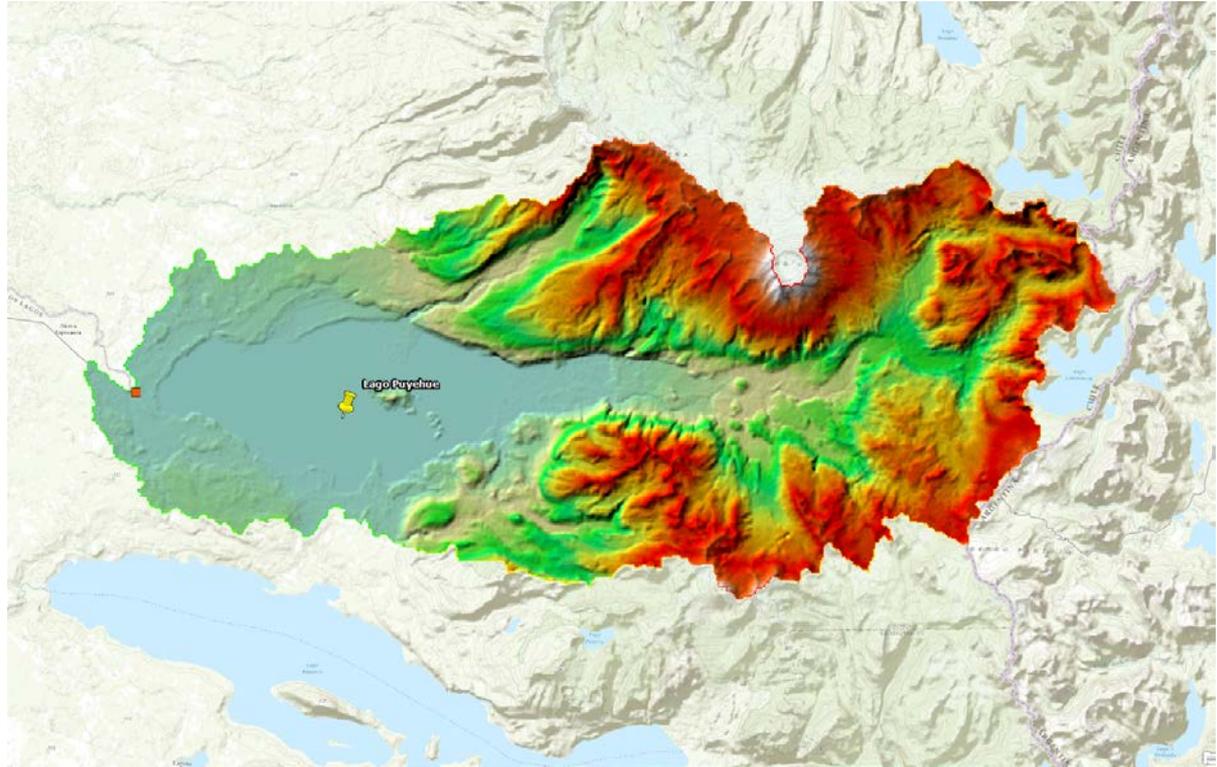
The point features used for calculating watersheds. These are referred to as pour points, because it is the location at which water pours out of the watershed.

Result



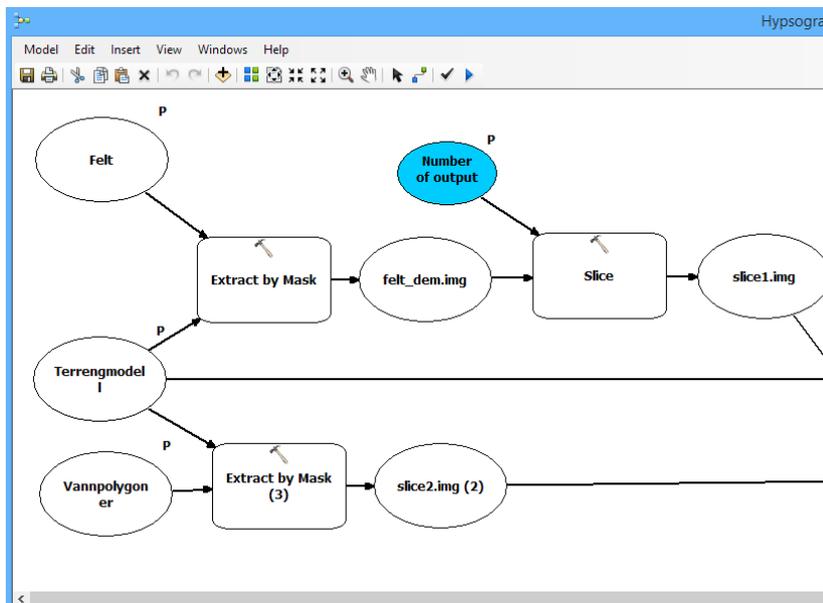
Model builder routines

- First, extract



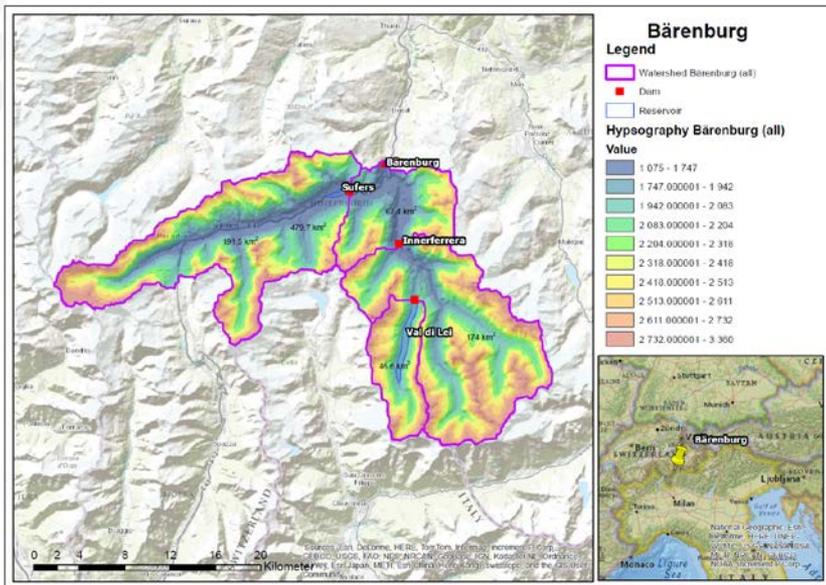
Model builder routines

- Then calculate hypsographic curve



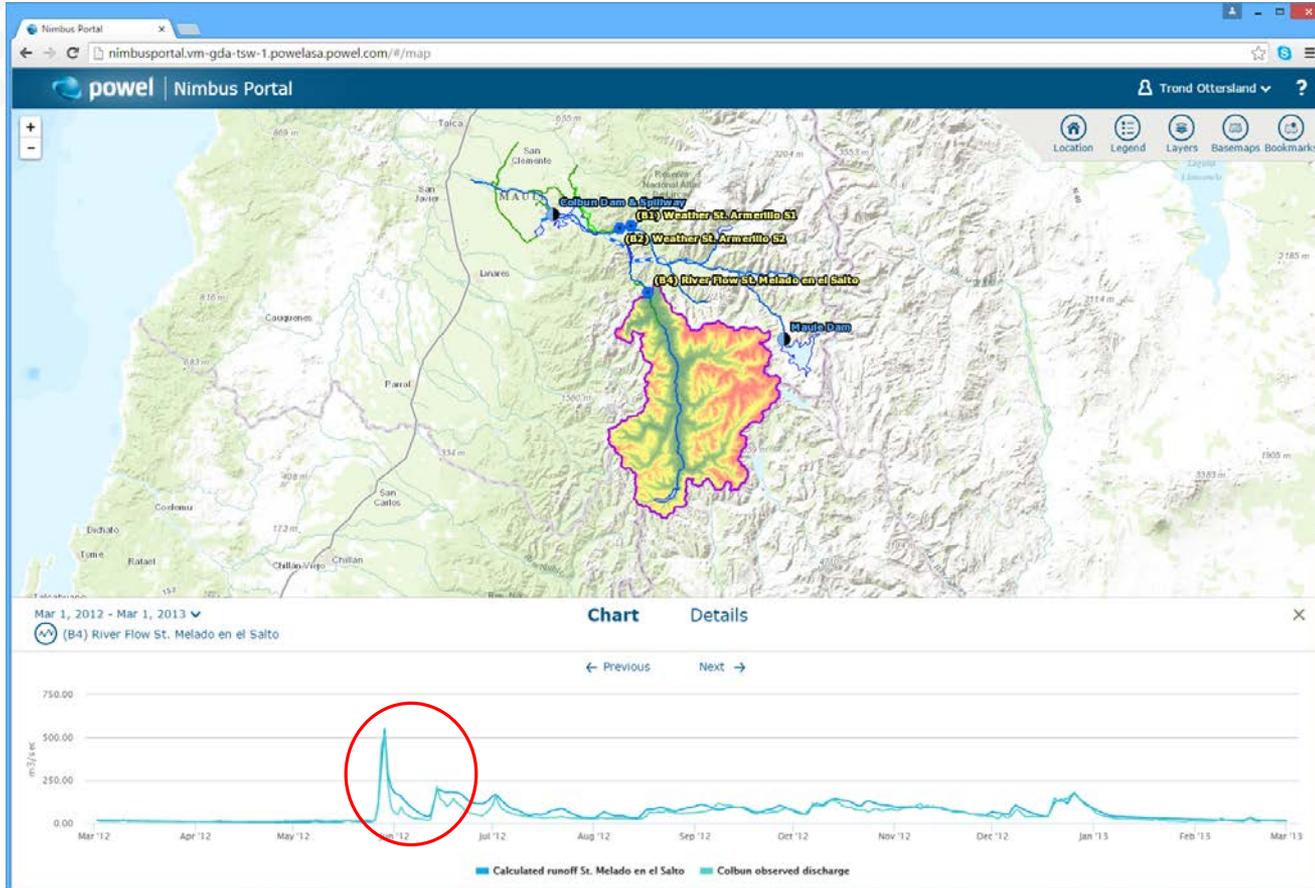
A	B	C	D	E	F	G	H
ZONE	AREA	AREA KM2	MIN	MAX	LAKE_AREA	LAKE_AREA KM2	LAKE_AREA Percent
1	5426100	5.4261	1075	1398	665100	0.6651	12.26 %
2	4248000	4.248	1399	1463	180900	0.1809	4.26 %
3	4776300	4.7763	1464	1510	5400	0.0054	0.11 %
4	4836600	4.8366	1511	1550			
5	4690800	4.6908	1551	1587			
6	4920300	4.9203	1588	1621			
7	4685400	4.6854	1622	1653			
8	4760100	4.7601	1654	1685			
9	4823100	4.8231	1686	1717			
10	4867200	4.8672	1718	1747			
11	4745700	4.7457	1748	1773			
12	4761000	4.761	1774	1797			
13	4911300	4.9113	1798	1820			
14	4806900	4.8069	1821	1841			
15	4724100	4.7241	1842	1862			
16	4859100	4.8591	1863	1883	900	0.0009	0.02 %
17	4753800	4.7538	1884	1893	2329200	2.3292	49.00 %
18	4948200	4.9482	1894	1909	865800	0.8658	17.50 %
19	4653000	4.653	1910	1925	308700	0.3087	6.63 %
20	4745700	4.7457	1926	1941	26100	0.0261	0.55 %
21	4925700	4.9257	1942	1957	4500	0.0045	0.09 %
22	4648500	4.6485	1958	1972			
23	4850100	4.8501	1973	1987			
24	4794300	4.7943	1988	2001			
25	4760100	4.7601	2002	2015			
26	4762800	4.7628	2016	2029			
27	4971600	4.9716	2030	2043			
28	4585500	4.5855	2044	2056			
29	4793400	4.7934	2057	2069			
30	4879800	4.8798	2070	2082			
31	4645800	4.6458	2083	2094			
32	4963500	4.9635	2095	2106			
33	4650300	4.6503	2107	2117			
34	4825800	4.8258	2118	2129			
35	4797900	4.7979	2130	2141			
36	4869000	4.869	2142	2153			
37	4729500	4.7295	2154	2165			
38	4749300	4.7493	2166	2177			
39	5053500	5.0535	2178	2190			
40	4635000	4.635	2191	2202			
41	4689900	4.6899	2203	2214			
42	4818600	4.8186	2215	2226			
43	4833900	4.8339	2227	2238			
44	4959000	4.959	2239	2250			

Output: Map and table



A	B	C	D	E	F	G	H
ZONE	AREA	AREA KM2	MIN	MAX	LAKE_AREA	LAKE_AREA KM2	LAKE_AREA Percent
1	5426100	5.4261	1075	1398	665100	0.6651	12.26 %
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18	4948200	4.9482	1894	1909	865800	0.8658	17.50 %
19	4653000	4.653	1910	1925	308700	0.3087	6.63 %
20	4745700	4.7457	1926	1941	26100	0.0261	0.55 %
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33	4650300	4.6503	2107	2117			
34	4825800	4.8258	2118	2129			
35	4797900	4.7979	2130	2141			
36	4869000	4.869	2142	2153			
37	4729500	4.7295	2154	2165			
38	4749300	4.7493	2166	2177			
39	5053500	5.0535	2178	2190			
40	4635000	4.635	2191	2202			
41	4689900	4.6899	2203	2214			
42	4818600	4.8186	2215	2226			
43	4833900	4.8339	2227	2238			
44	4959000	4.959	2239	2250			

Result analysis





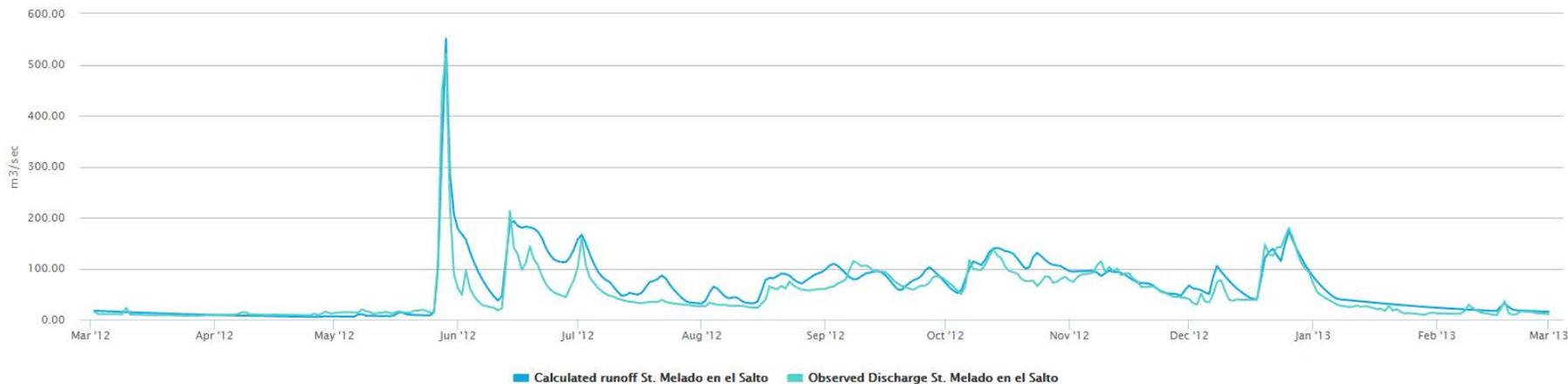
2012-03-01 - 2013-03-01 ▾ Colbun



Table **Chart** Details

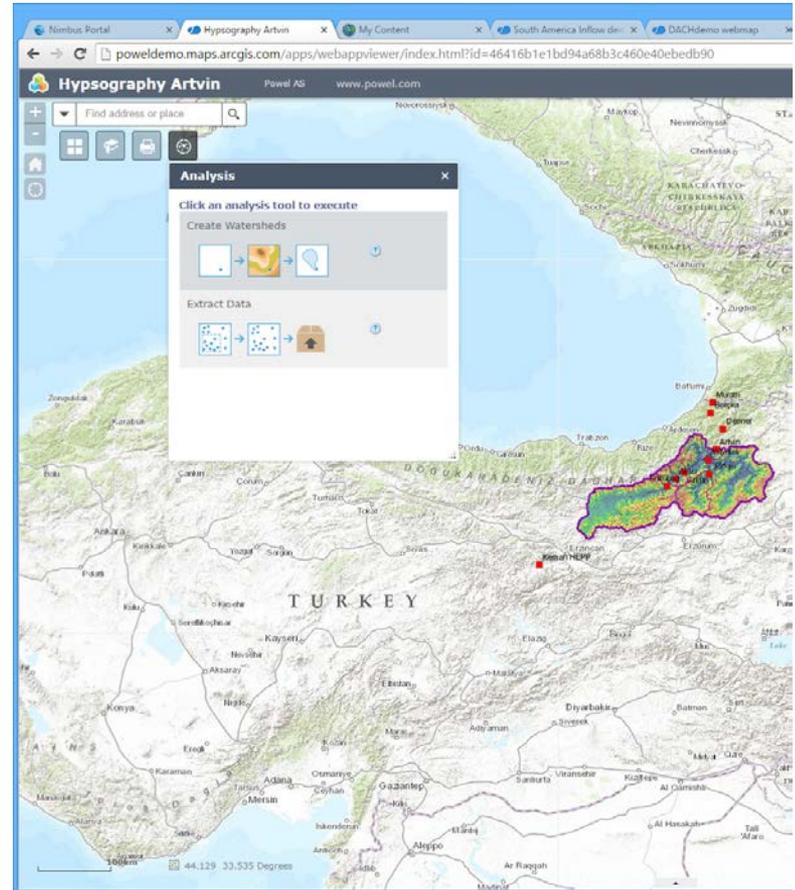
← Previous period

Next period →



Improvements

- More detailed lake data, 1:250.000 would be nice
- Utilize hillshade to help setting points for watershed in difficult areas
- Share tools with colleagues in webapp for self service
- What about customers?



Questions in panel later, or

- trond.ottersland@powel.no
- Details about HBV-model:
 - https://en.wikipedia.org/wiki/HBV_hydrology_model
 - <http://www.smhi.se/forskning/forskningsomraden/hydrologi/hbv-1.1566>
- Powel Inflow:
 - http://www.powel.com/about/feature_stories/inflow-forecast-for-hydropower-plants/

