Groundwater Assessment Platform

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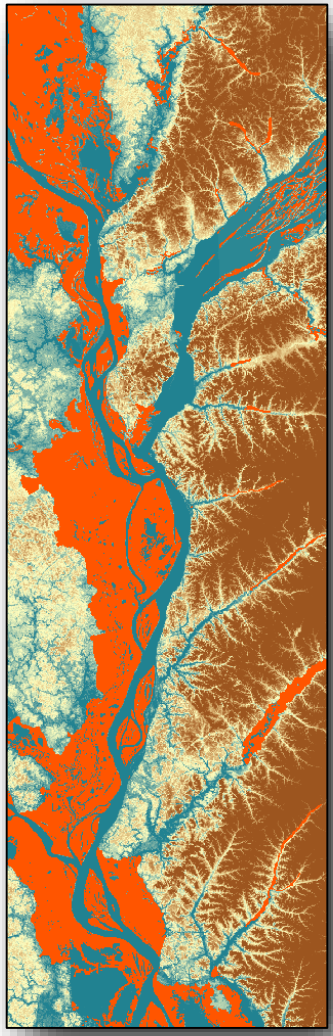
GIS-BASED GROUNDWATER QUALITY ASSESSMENT AND PREDICTION WITH THE GROUNDWATER ASSESSMENT PLATFORM (GAP)

Joel Podgorski, joel.podgorski@eawag.ch



eawag aquatic research

Swiss Federal Institute of Aquatic Science and Technology

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Geogenic (natural) groundwater contamination

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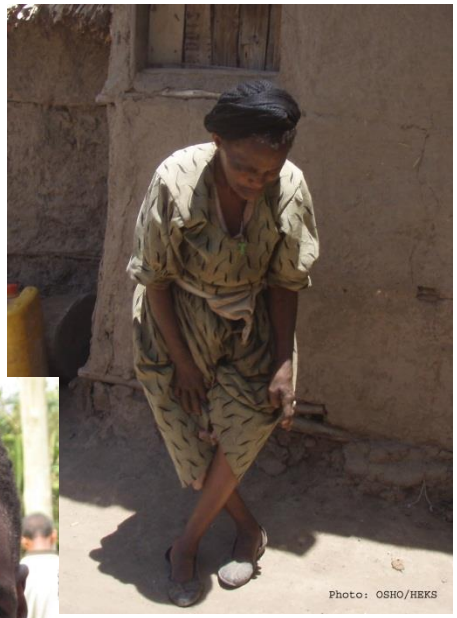
- **Geogenic contamination is widespread, affecting up to 10% of wells worldwide**
- **Over 300 million people globally are exposed to high levels of arsenic (As) and fluoride (F)**
- **Little is being done to combat the situation in low-income countries**

Arsenic (~140 million)
causes skin lesions, pulmonary disorders, internal cancers
WHO: 10 μg/L

Fluoride (~200 million)
causes dental mottling & decay and crippling skeletal deformation
WHO: 1.5 mg/L



2008 global arsenic map (Ravenscroft et al., 2008)

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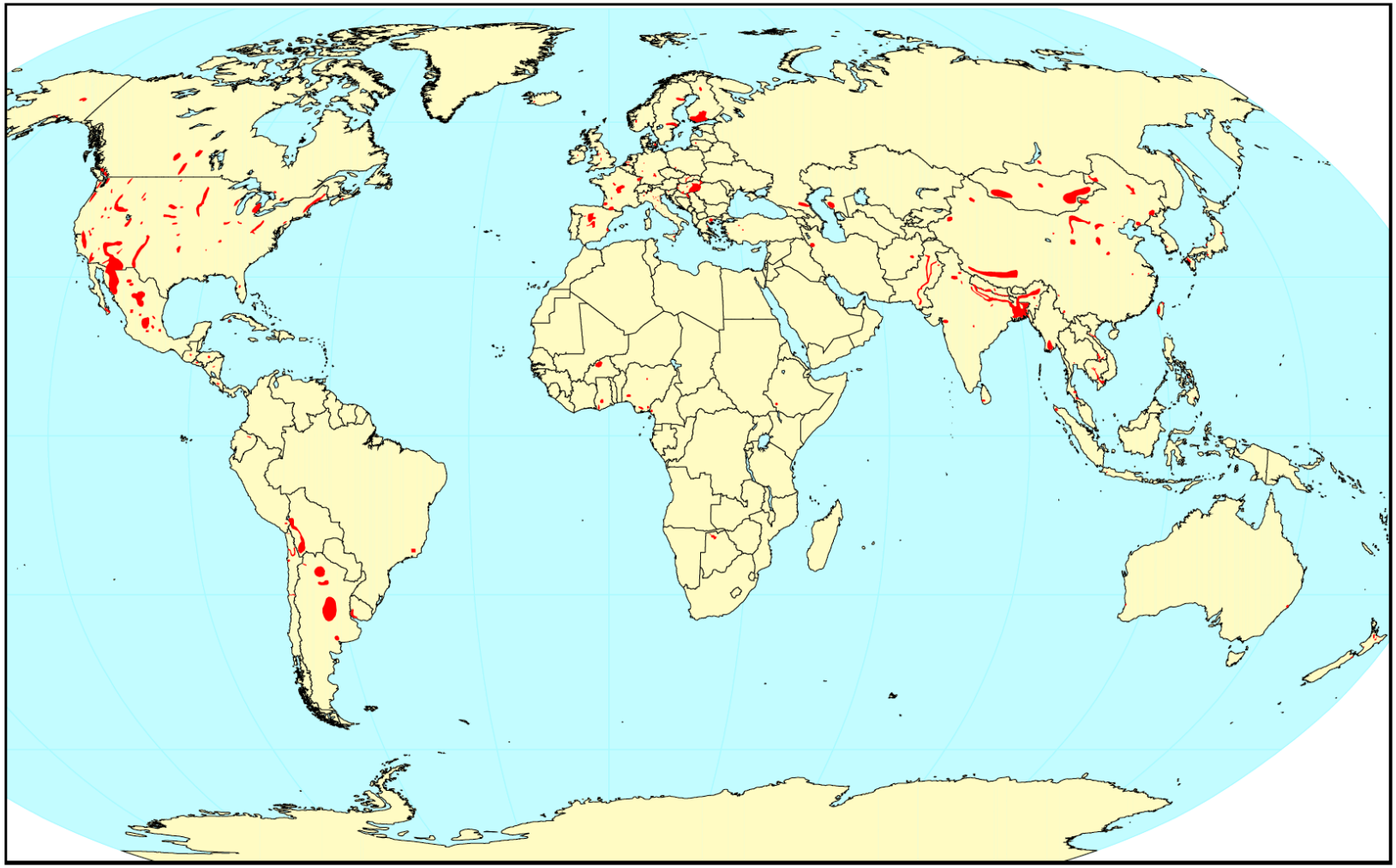
Various regions discovered in recent years

But large areas are still uncharted



Global risk map for **As** >10 µg/L

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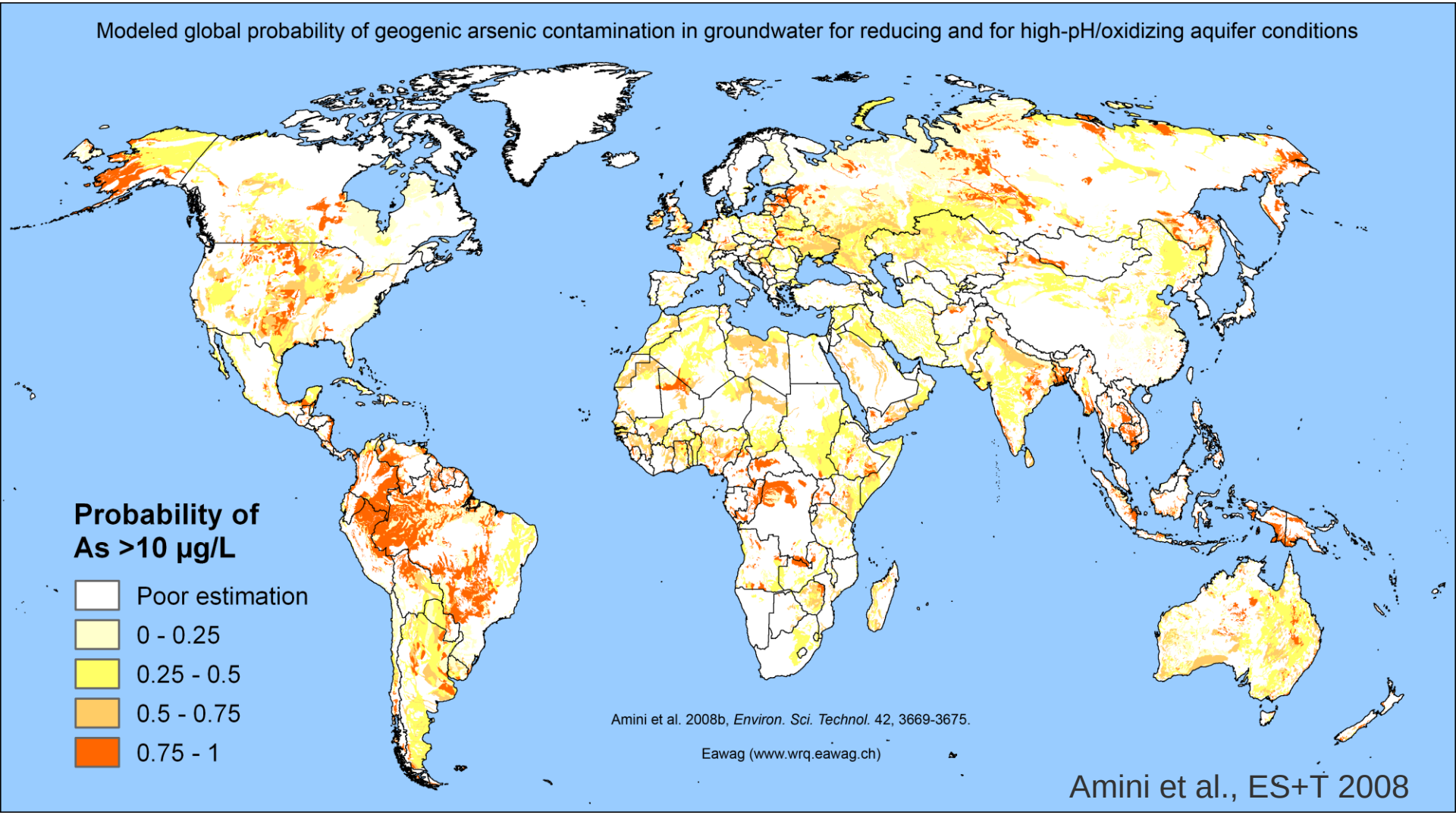
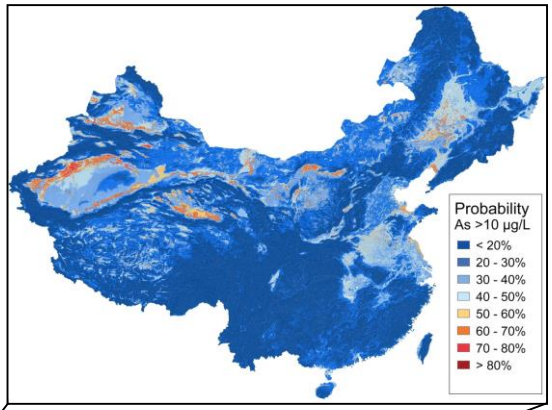


Probability modeling

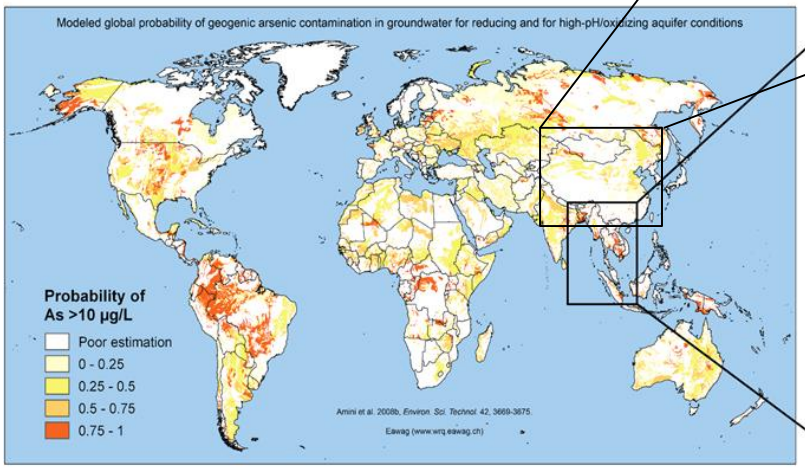
Arsenic probability modeling at different scales:

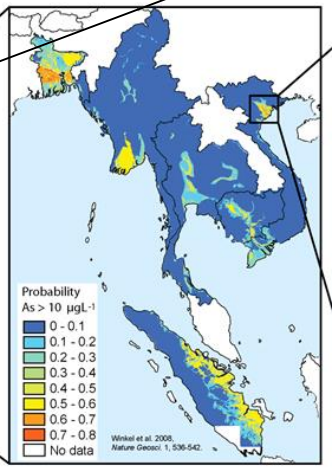
China

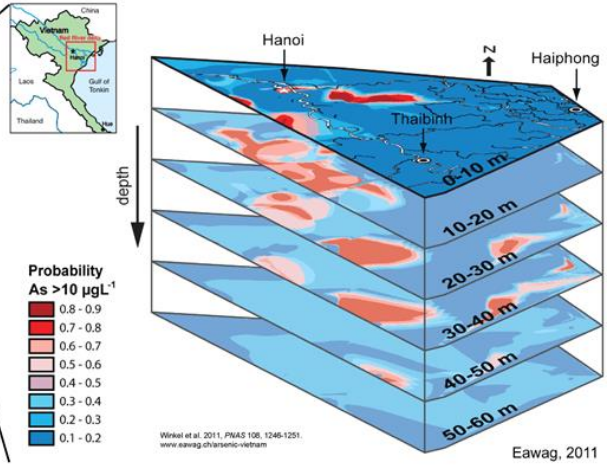


South East Asia

Red River delta, Vietnam







Global

Regional

River basin in 3D

Concept of geostatistical prediction modeling

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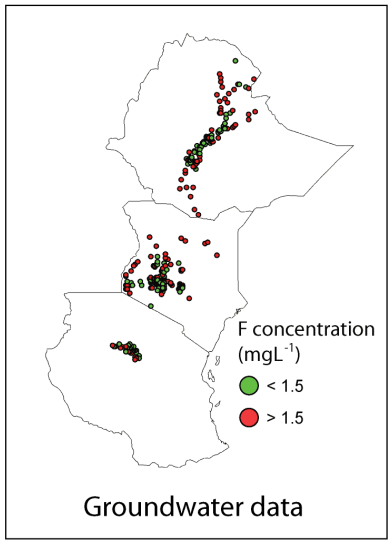
Concentration data → Geo-statistical modeling → Identifying risk areas → Mitigation



Relevant geospatial data

- Increasingly available in digital GIS format
- Often free of charge
- Resolution and coverage increasing

Logistic regression

Gives the probability of a binary (0 or 1) target variable being "positive" (i.e. true or 1) for a linear combination of predictor variables:

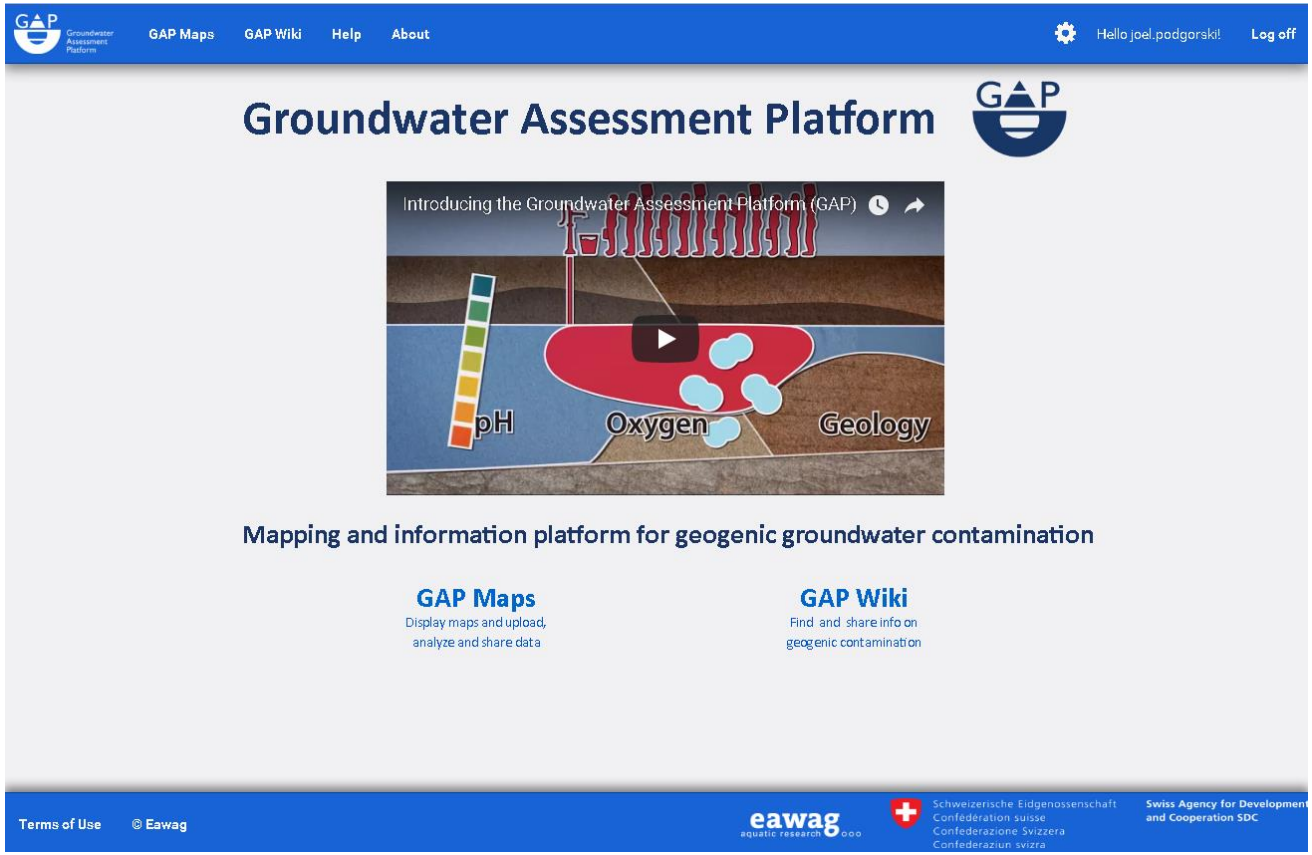
$$P(x) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

where *P* is probability, β is a regression coefficient, *x* is an independent variable.

Groundwater Assessment Platform

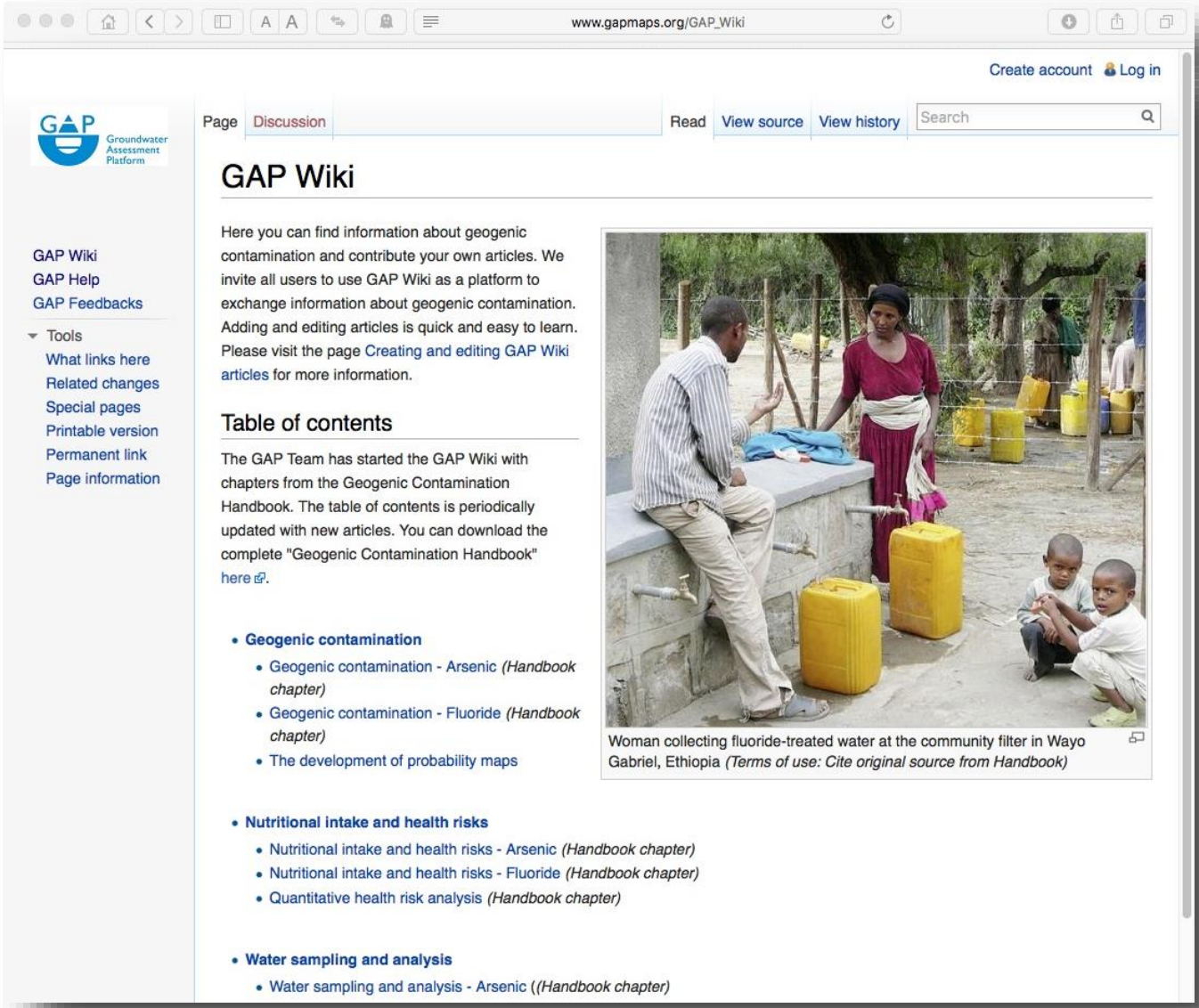
www.gapmaps.org

Free, interactive online GIS platform for **mapping**, **statistical modeling** and **dissemination** of information on geogenic groundwater contamination



- Mapping
- Modeling
- Sharing
- Wiki

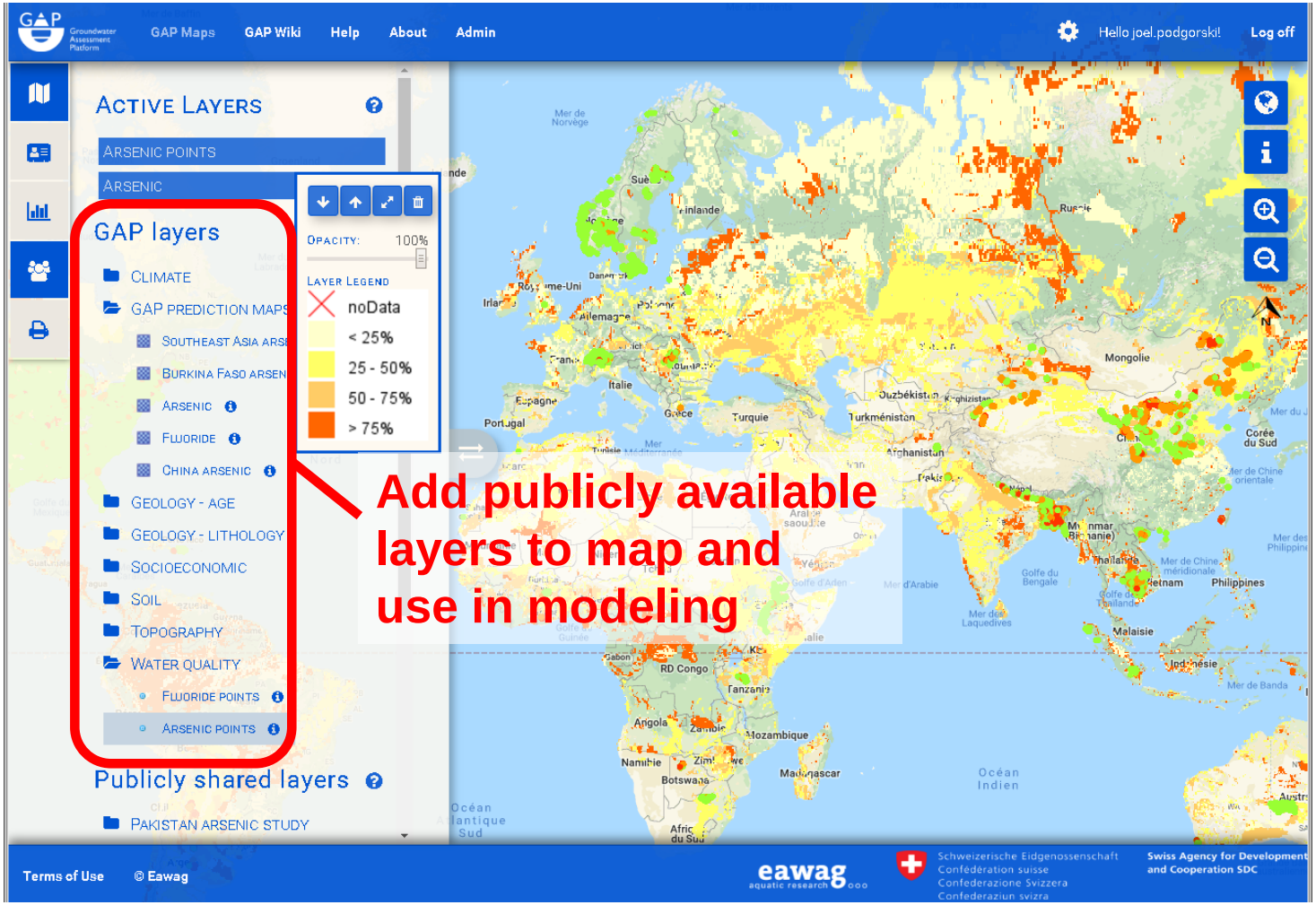
GAP Wiki – help to expand the compendium



Features the **Geogenic Contamination Handbook**

Read/add/edit pages on the subject of geogenic contamination

GAP core functionality



PUBLIC

- View existing models and data

PRIVATE (login)

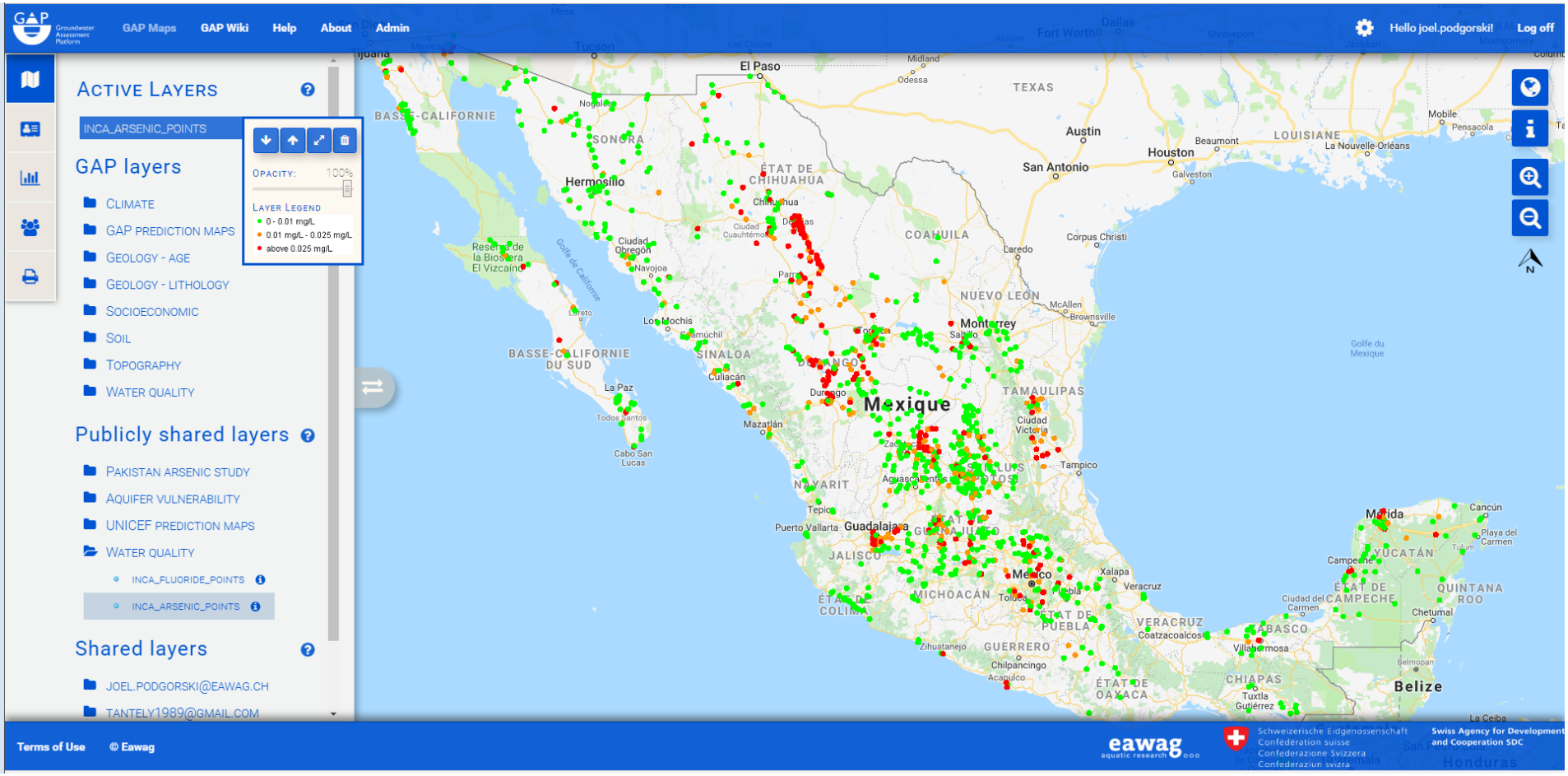
- Upload, display & share own data
- Create own predictive model

COMMUNITY

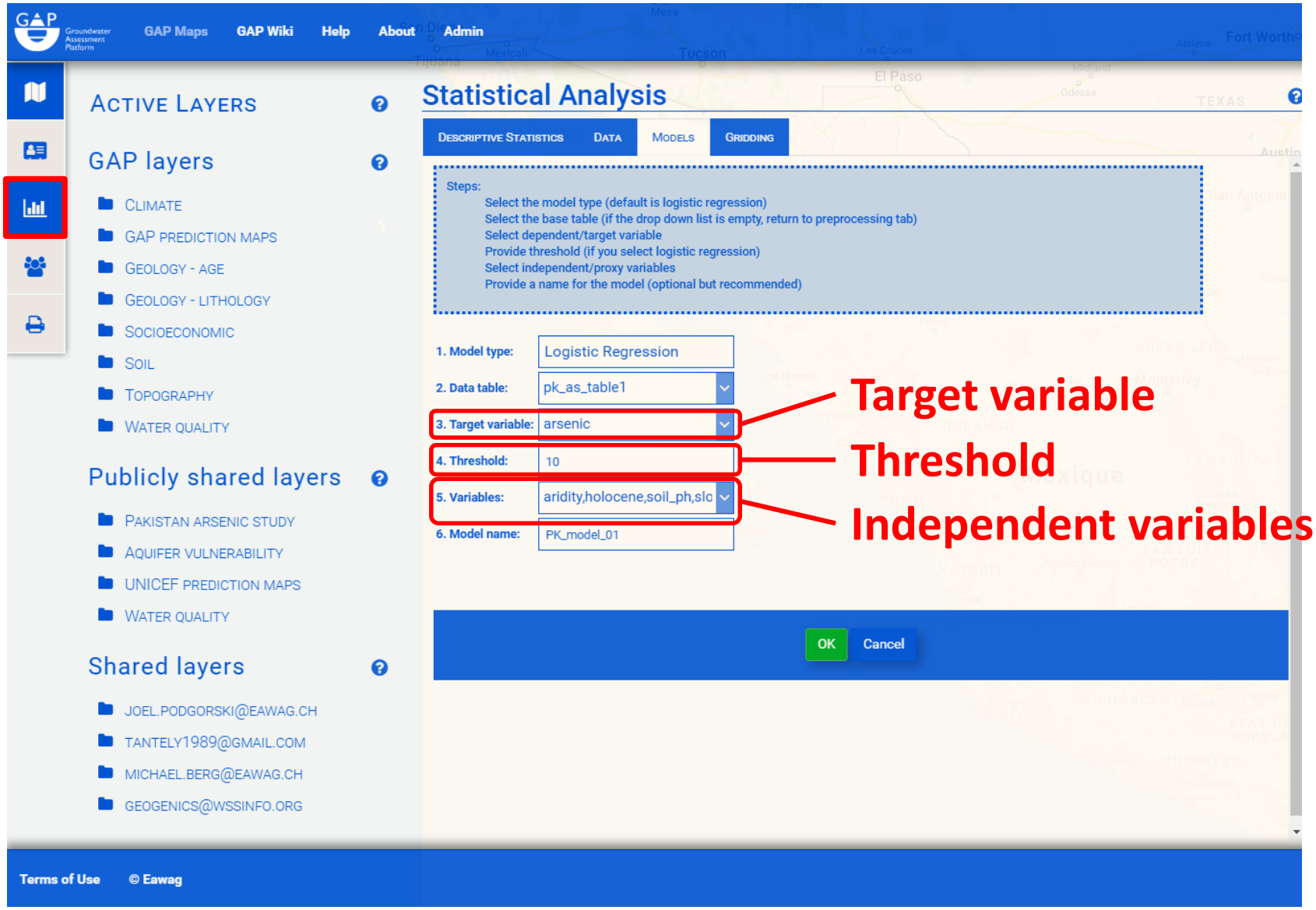
- Share data and models with user-created communities

Modify symbology and share data publicly

Example: arsenic concentrations from Mexico



Statistical modeling



Model output in GAP

Coefficients of independent variables

Statistical Analysis

DESCRIPTIVE STATISTICS | DATA | MODELS | GRIDDING

Return

Model coefficients

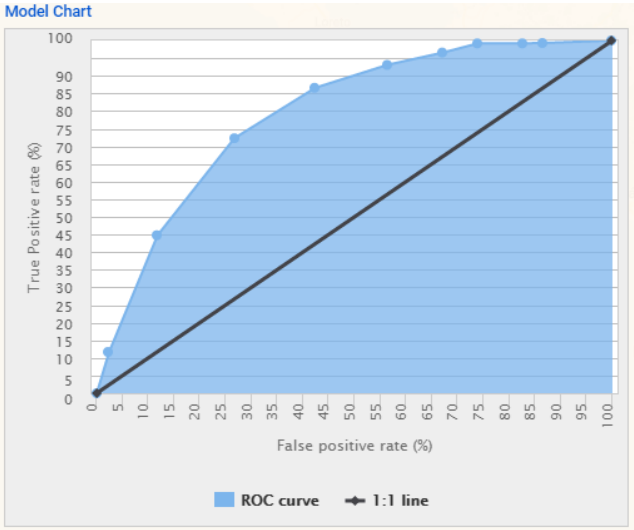
	Id	Step	Parameter	Coefficient	Std	Wald	Odds	Lower	Upper	P-value
1	113	0	Intercept	-7.38	1.49	-4.94	0.00	0.00	0.01	0.000
2	113	0	holocene	-0.30	0.15	-1.95	0.74	0.55	1.00	0.051
3	113	0	slope	-0.29	0.08	-3.57	0.75	0.64	0.88	0.000
4	113	0	soil_fluvisols_pk_v2	0.03	0.01	6.33	1.03	1.02	1.05	0.000
5	113	0	soil_ph_mosaic_soilgrids_h	1.06	0.17	6.16	2.88	2.06	4.03	0.000
6	113	0	soil_oc_soilgrids6m_hwsds	-0.58	0.16	-3.62	0.56	0.41	0.77	0.000

Model classification

	Id	Cutoff	Measured hig	Measured lov	Predicted hig	Predicted low	False pos. rat	False neg. rat	Sensitivity	Spec
1	113	0	835	415	835	0	1	0	1	0
2	113	0.1	835	415	829	56	0.865	0.007	0.993	0.135
3	113	0.2	835	415	828	72	0.827	0.008	0.992	0.173
4	113	0.3	835	415	828	108	0.74	0.008	0.992	0.26
5	113	0.4	835	415	807	136	0.672	0.034	0.966	0.328
6	113	0.5	835	415	777	181	0.564	0.069	0.931	0.436
7	113	0.6	835	415	723	239	0.424	0.134	0.866	0.576
8	113	0.7	835	415	604	304	0.267	0.277	0.723	0.733
9	113	0.8	835	415	374	366	0.118	0.552	0.448	0.882
10	113	0.9	835	415	98	405	0.024	0.883	0.117	0.976

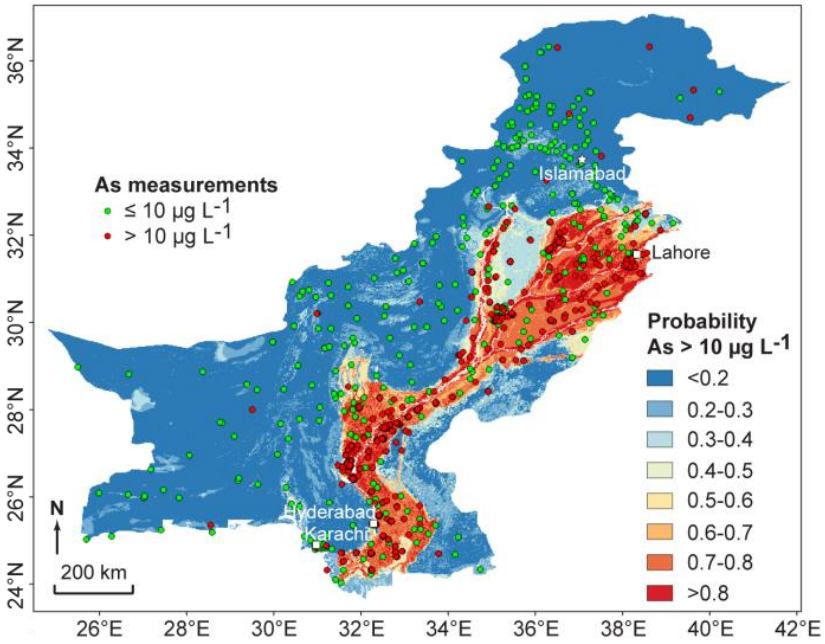
Statistics with different cutoff values

ROC curve



Modeling comparison: manual coding vs. GAP

Arsenic prediction map for Pakistan
created offline with the R language

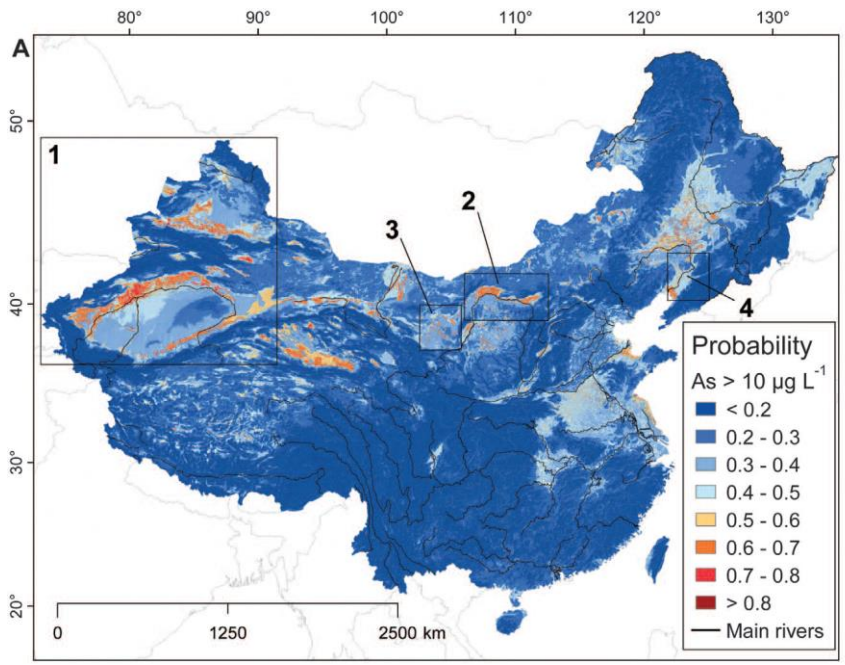


Podgorski et al., 2017

Predictor variables:
slope, fluvisols, Holocene fluvial sediments, soil organic carbon, soil pH

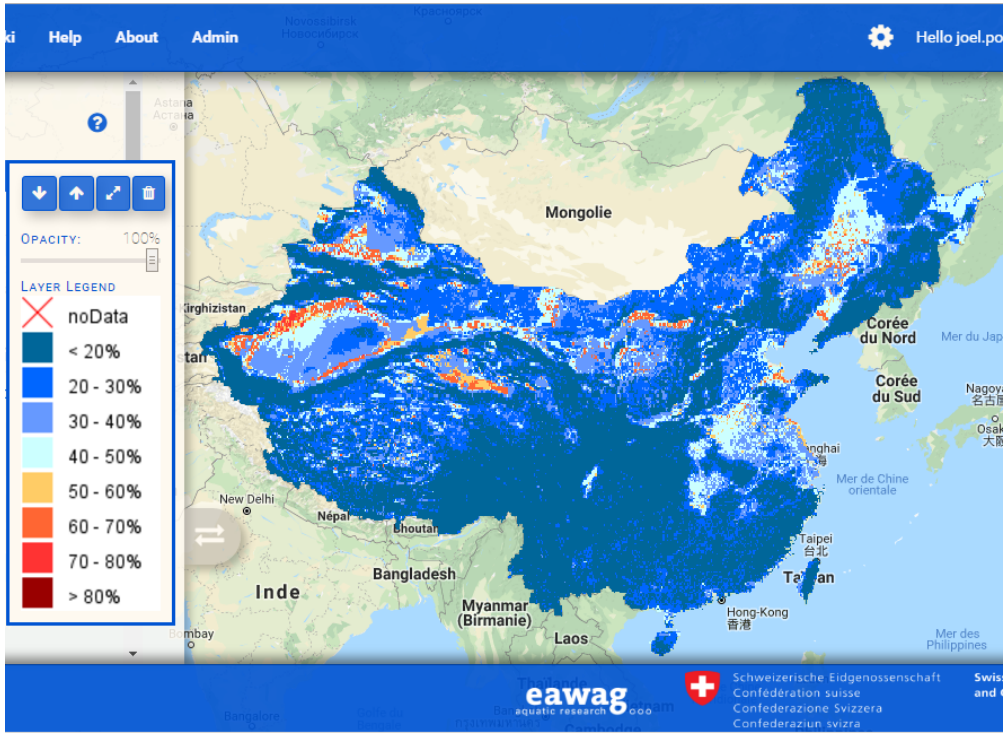
Modeling comparison: China

Arsenic prediction map for China created offline



Rodríguez-Lado et al., 2013

Arsenic prediction map for China created in GAP



→ **Very similar results between modeling via manual coding and modeling with GAP**

Thank you

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Print PDF of area of interest

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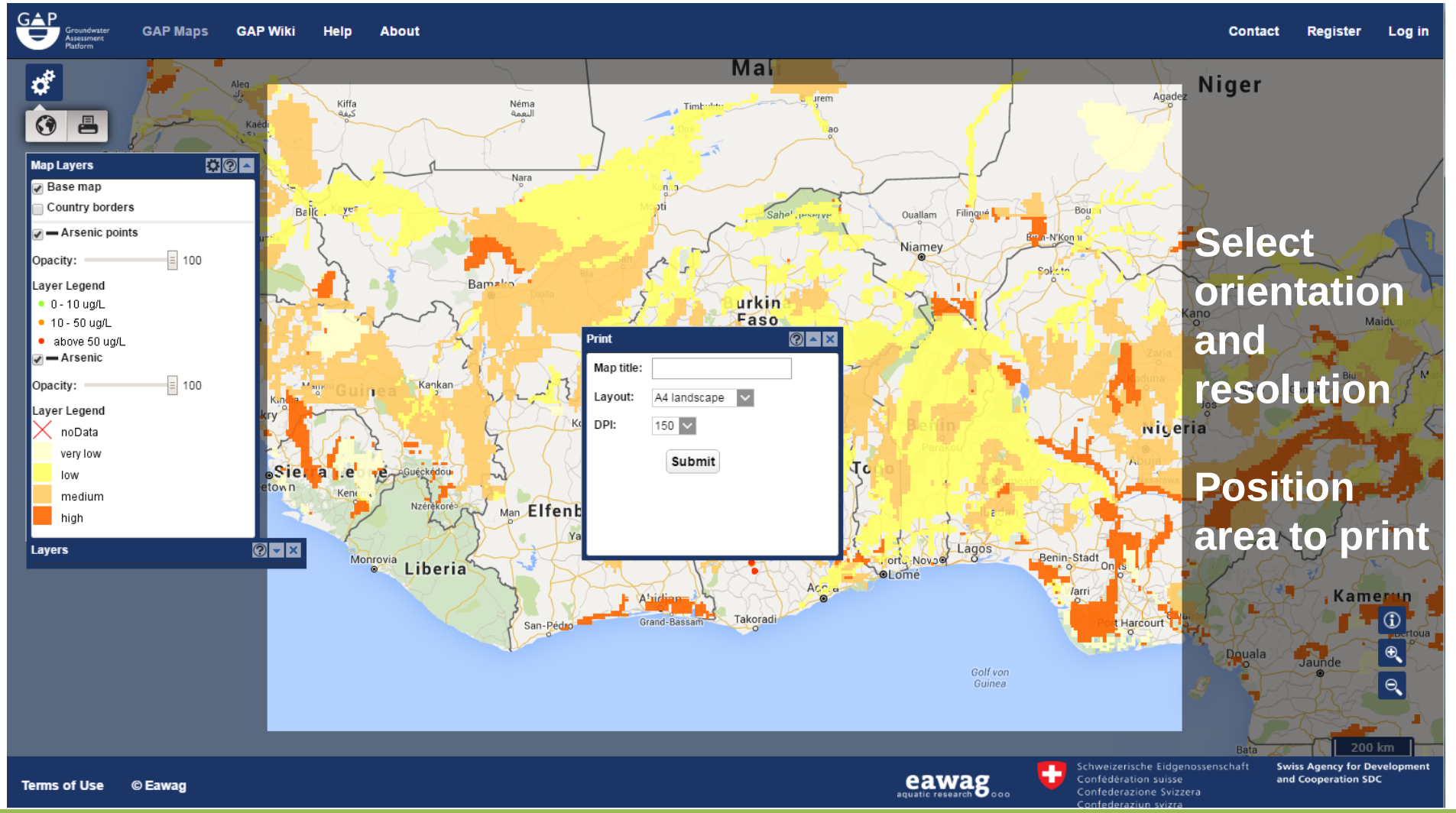
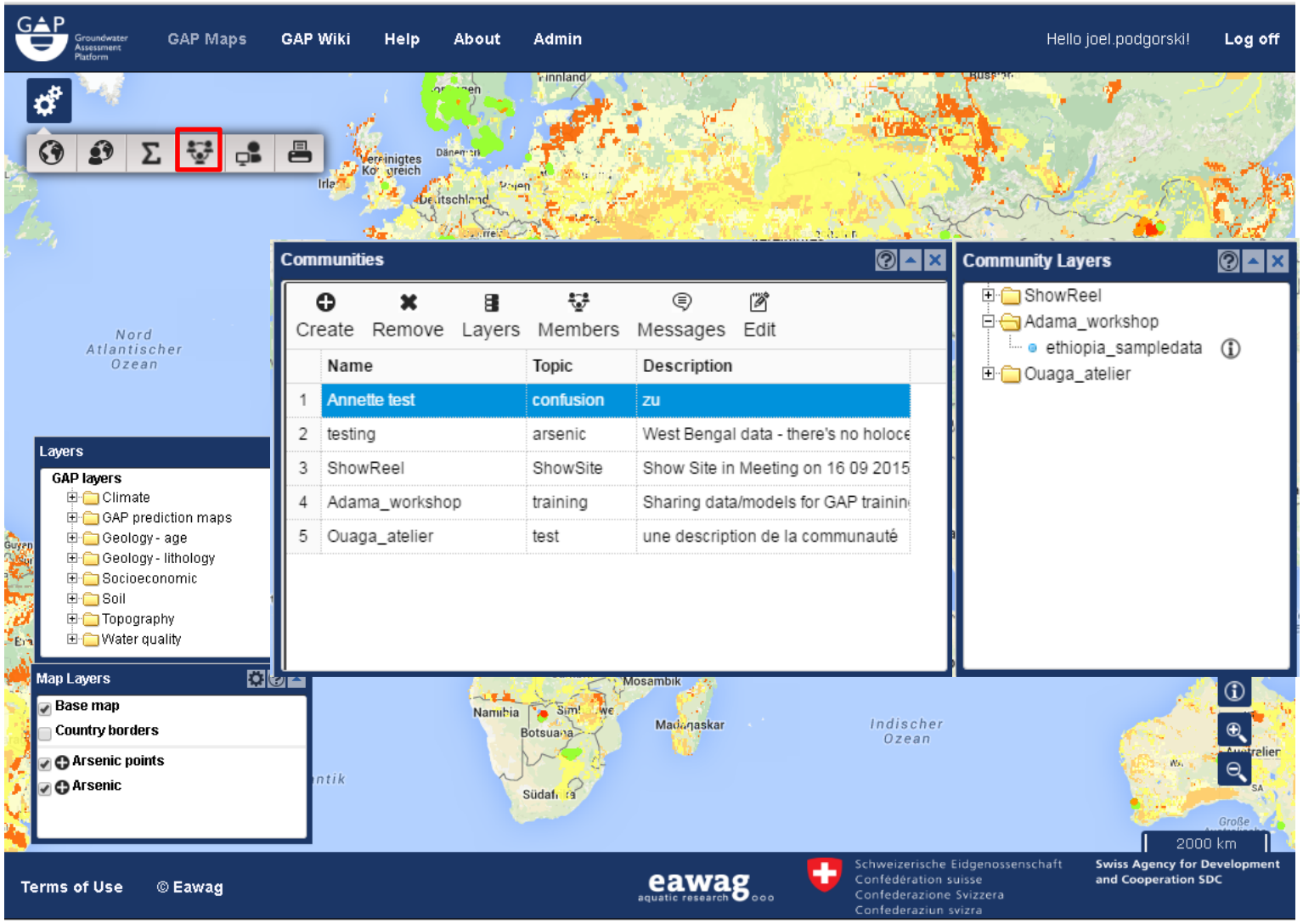


→ Can also export GIS layer of own data/models

Communities

Share data and models with a select group of users



Help

page | discussion | view source | history

GAP Help

The Groundwater Assessment Platform (GAP; www.gapmaps.org) hosts information on geogenic contamination of groundwater by arsenic and fluoride. It provides tl
and field experiences as well as to interact with other users and create probabilistic maps for any area on the globe. The site has *two main sections* (Figure 1). In **GAP M**
enic contamination.

navigation
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- GAP Help
- GAP Feedbacks

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- Related changes
- Special pages
- Printable version
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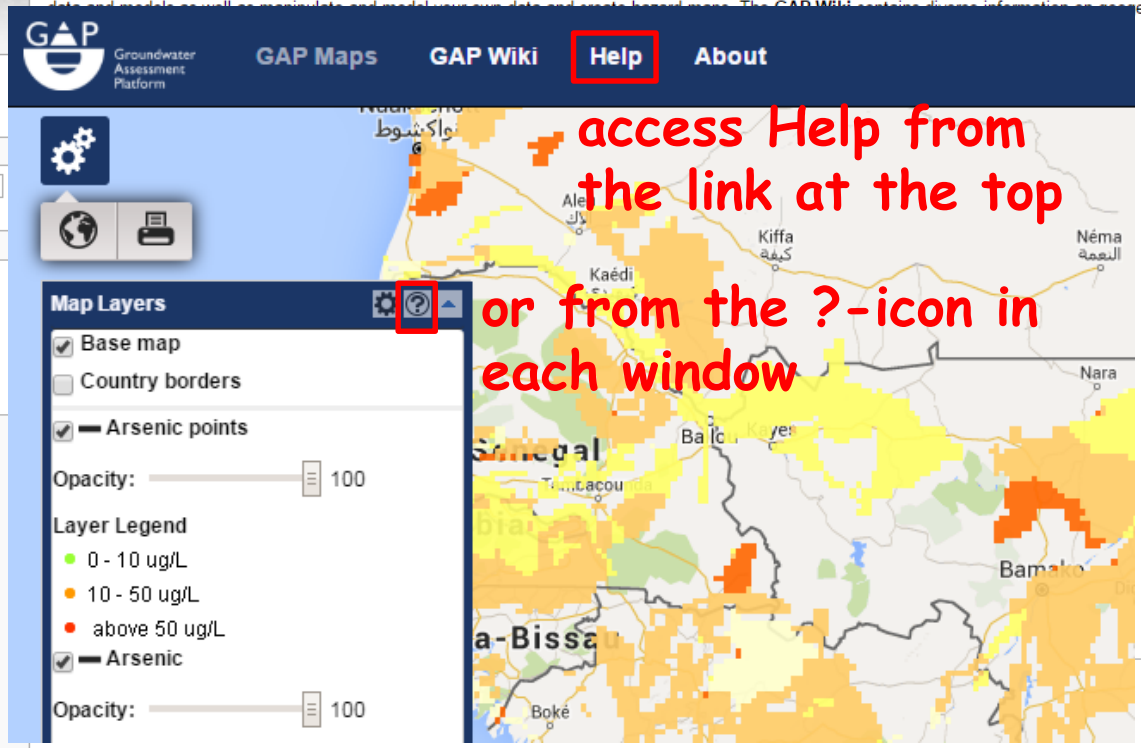
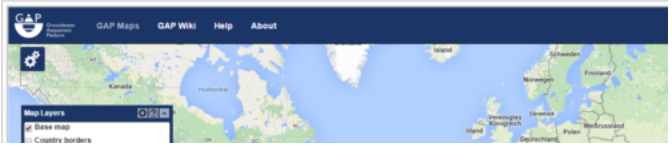
- Page information



In case you have questions or require help while using the site, you can click on **Help** in the top bar to open the help page, which explains all of the features of GAP Ma



Additional functionality when logged in