A Web-GIS application for the monitoring of Farm Animal Genetic Resources (FAnGR)

Author:
Solange Duruz

Supervisor:
Stéphane Joost
Expert:
Christine Flury



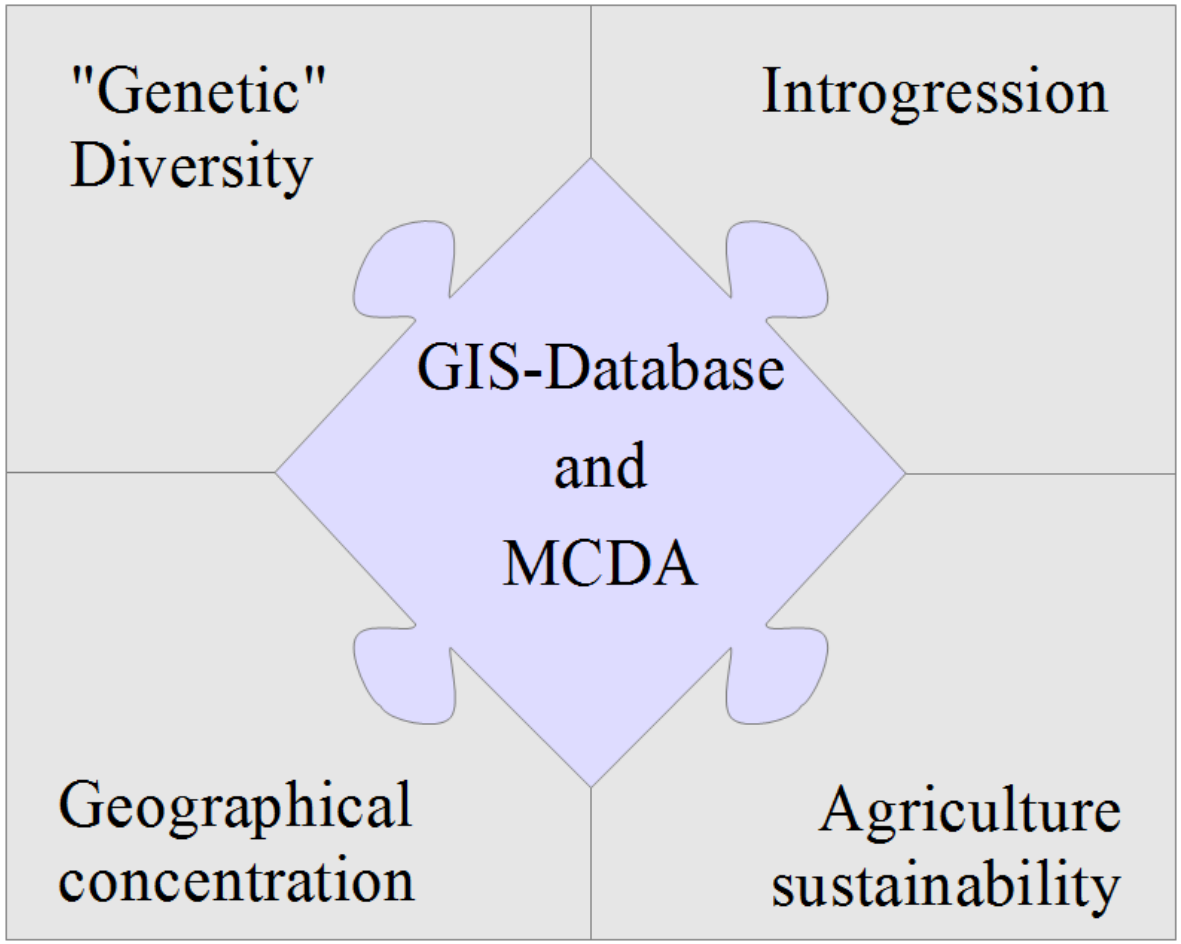
Context

- Loss of genetic diversity in Farm Animal
  - Cause: selection of more productive breeds
  - Consequence: higher risk of extinction
- FAO protocol (FAO, 2007): Global plan of action for Animal Genetic Resources
- $\rightarrow$ Need for a tool to identify endangered breed

Goal

- Develop of **GenMon-CH**, a Web-GIS application
- Identify most endangered breeds
- Include different kinds of criteria
  → Multi-criteria decision help tool
- Identify problems of each breed
- See spatial distribution of breeds

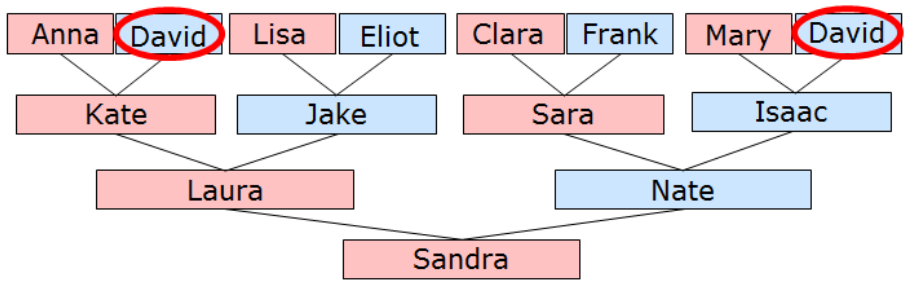
Criteria to consider?



Goal: build **global index** integrating all 4 criteria

Pedigree

- "Genetic" diversity increases resistance to epidemics
- Estimated from pedigree data



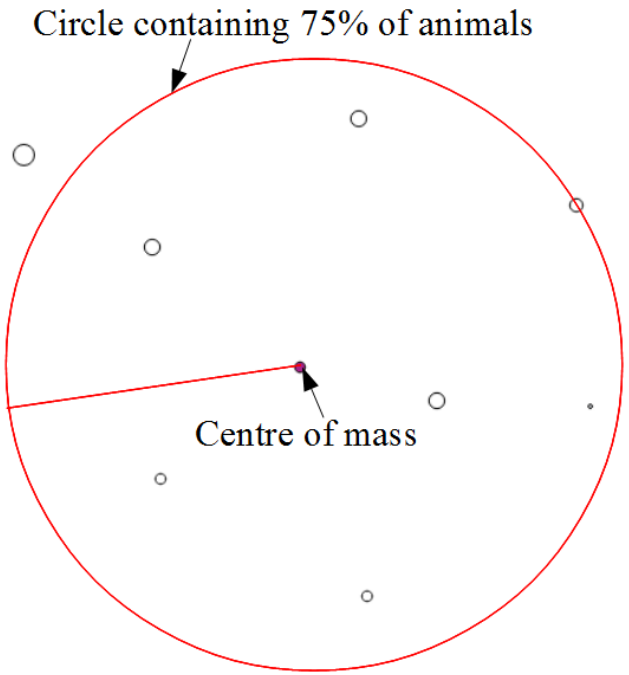
- Pedigree Analysis run in PopRep (Groeneveld et al., 2009)

Introgression

- Process of mating with another breeds
- Consequence: mixing of traits
- User enters introgression at animal level
- Computation of mean introgression over last generation interval

Geog concentration

- Measure of the spread over the territory
  → Important to restrict the spread of diseases
- Animals geolocated with their Postal code
- Smallest circle containing at least 75% of animals, centered around the centre of mass of the breed
  (Alderson, 2010)



Agric sustainability

- Breed sustainability also depends on likelihood of agriculture abandonment
- Includes:
  - Socio-Economic Criteria (demographic balance, % below 19 years old, % above 65 years old, social assistance rate)
  - Relative importance of agriculture (% farmer, % surface for grazing, evolution number of jobs in agriculture)
  - Projected landuse (Price et al., 2013)
- Statistics available at the commune level

Criteria Aggregation

- **Data integration:** Link through Geography, but
  - Animal geolocated by Postal Code
  - Statistics at the Commune-level
  - Landuse scenario as grid

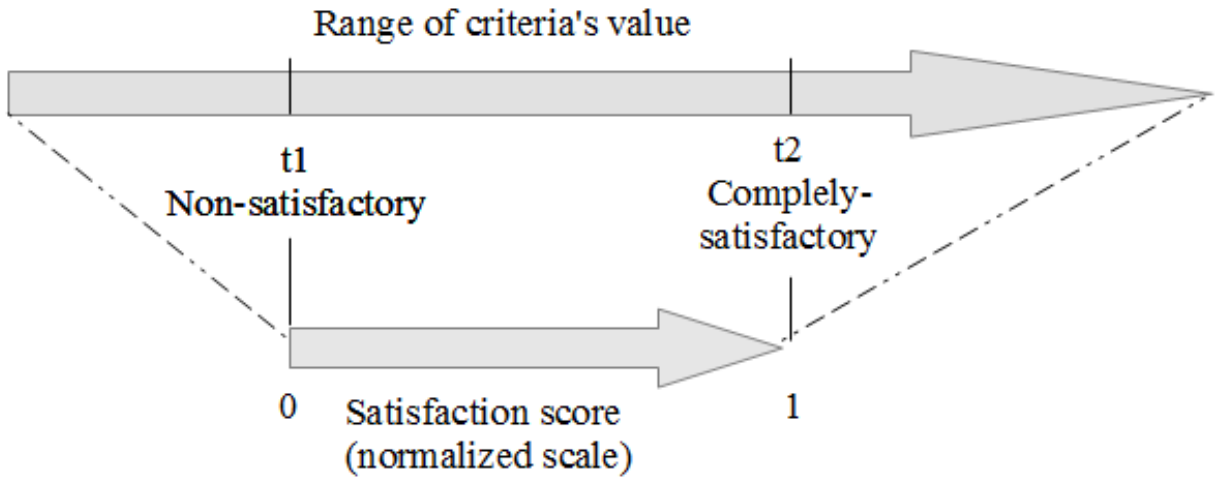
  → Need of GIS-analysis

  → Use centroid of ZIP-code falling in a given commune

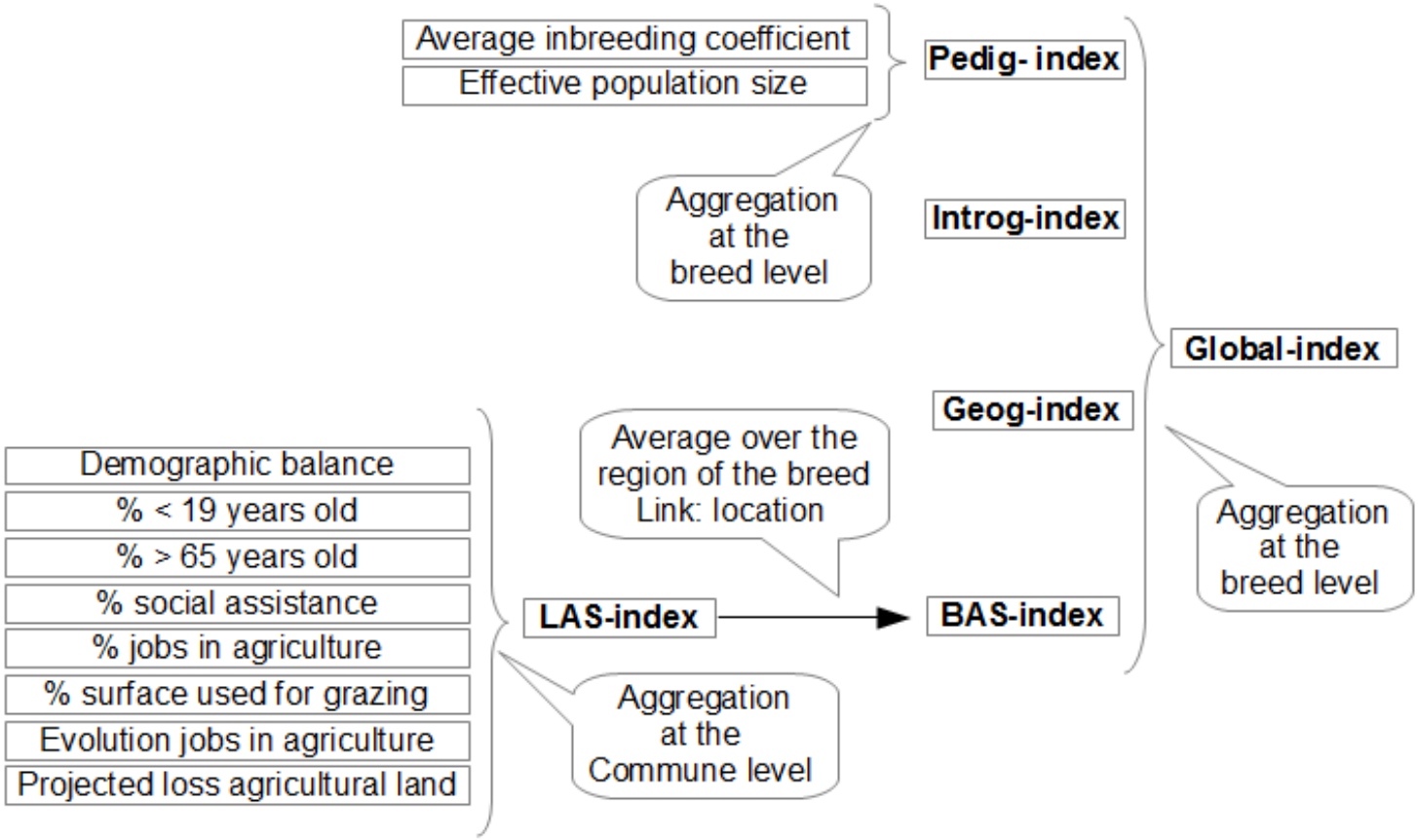
Criteria Aggregation

- Aggregation using MCDA-technique: MACBETH (Costa et al., 1994)
  - Weighted average
  - using satisfaction thresholds

  → Expert-based approach



Criteria Aggregation



Data

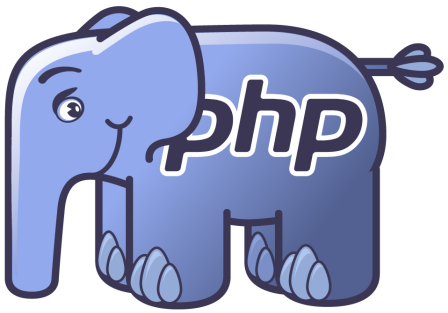
- Animal information
  - Pedigree info
  - Introgression
  - Geographic location (Postal Code)

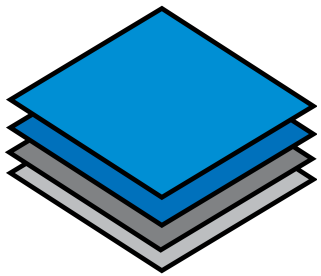
```
animal_ID;sire_ID;dam_id;birth;sex;plz; intro;inb;cryo_cons
73400;70335;358651;1951;M;3057;0;;0
398242;16590;7756462;1994;F;1971;0.1;;0
```

- Statistics (Socio-Economic/Enviro) at the commune level
- Shapefile of Communes and Postal Code

Implementation

- Web-interface: HTML-PHP
- Database: PostgreSQL/PostGIS
- Map: Openlayers and Javascripts
- Pedigree Analysis: PopRep (FLI)





Web-interface

- HTML
- PHP: object oriented language, communication with DataBase
- CSS: visual output
- Others: Ex flot library to output graphs

Database: PGSQL

- Advantages
  - Open source, reliable, well documented
  - Spatial extension PostGIS
  - Publishing through Geoserver
  - Communication with PopRep
- Structure, Tables
  - Summary tables
  - $\backsim$ 10 tables per breeds (individual level, per year, per ZIP code)
  - Membership, password
  - Spatial table (ZIP code and communes)

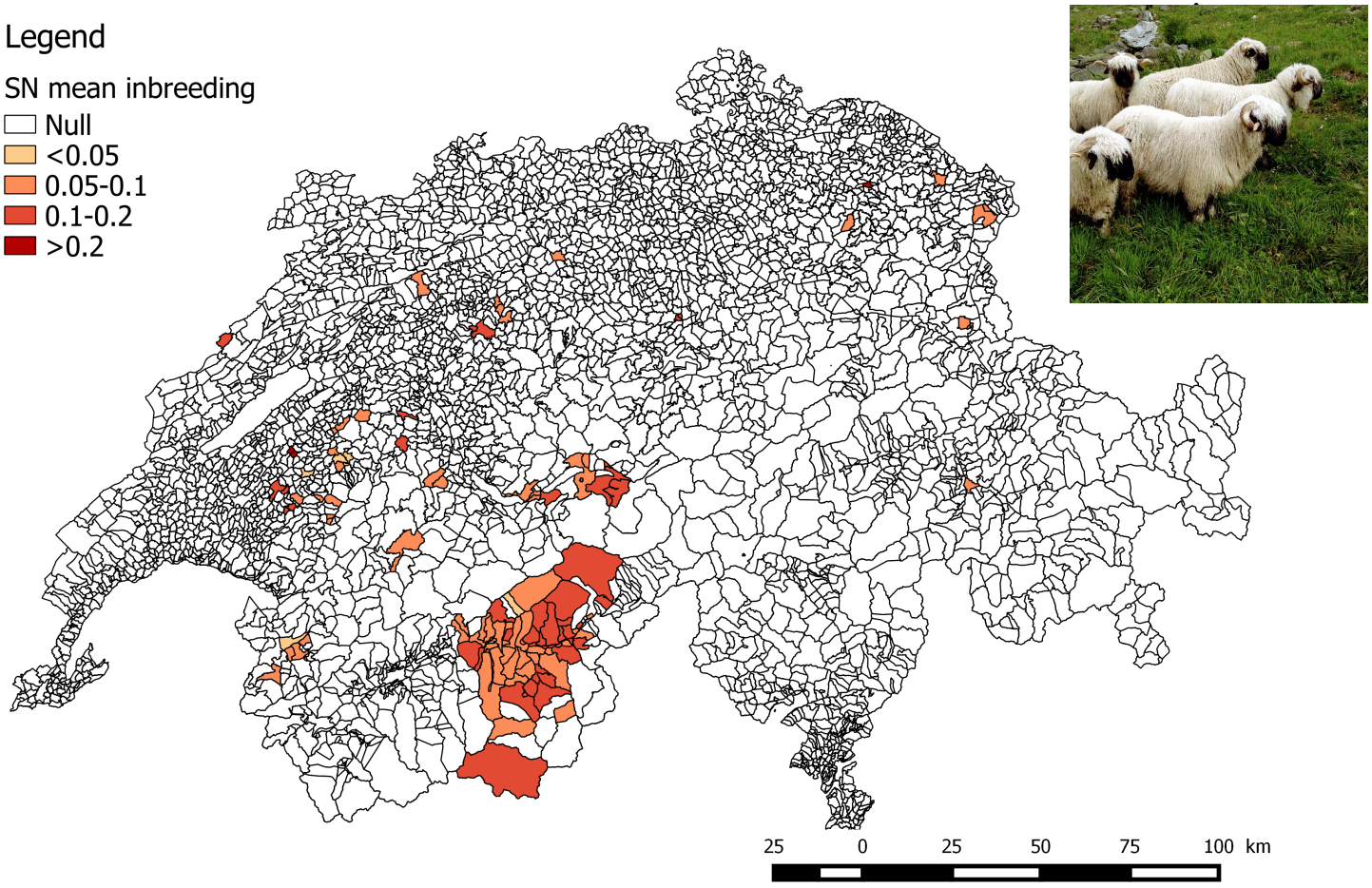
Map

- Geography stored in PostGIS
- Map published through Geoserver
- Display using Openlayers (javascript library)
- Map displayed with WMS (image, static)
- Querying with WFS (dynamic querying)

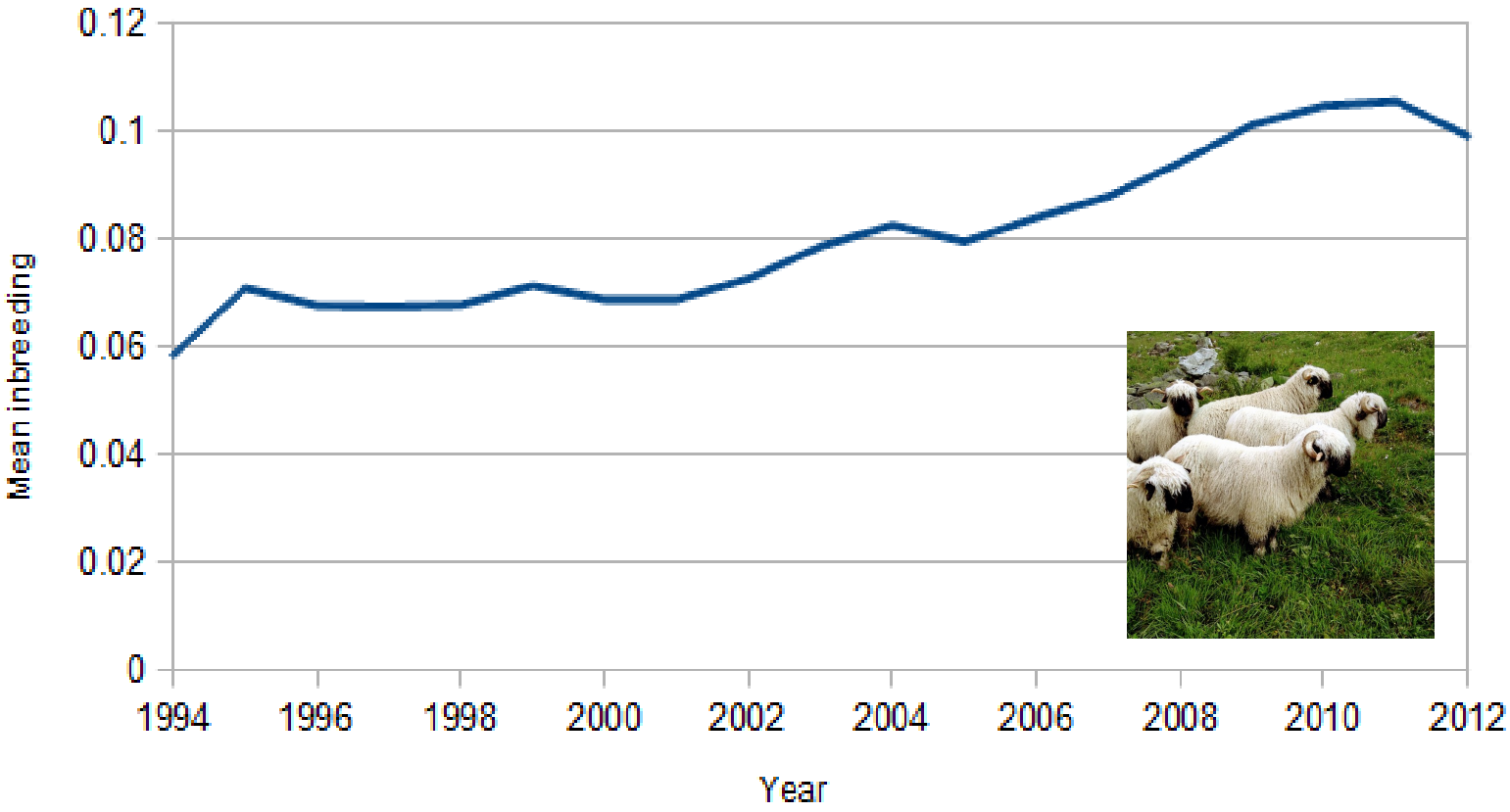
Ranking of breeds

Breed name	Mean F	N_e range	pedig-index	introg-index	geog-index	BAS-index	global-index
SN	0.103	50-100	0.008	0	13.02	0.78	0.393
FM	0.057	50-100	0.383	0.114	57.66	0.75	0.454
BFS	0.0467	50-100	0.474	0	51.58	0.707	0.703
SBS	0.0411	50-100	0.523	0	59.53	0.719	0.746
BVO	0.033	50-100	0.594	0.013	58.52	0.74	0.812

Mean Inbreeding Blacknose sheep



Mean Inbreeding Blacknose sheep



Demo

lasigpc49.epfl.ch/genmon-ch

Conclusion

- Easy-to-use Web-GIS application
- Integration of various criteria
- Ranking of endangered breed + Identification of problems
- Maps available
- **Geography** needed for:
  - Link/Integration of different data types
  - Calculate geographical concentration

Thank you for your attention ...Questions?

Alderson, L. (2010). Breeds at risk. In *Criteria and classification. report from a seminar* (pp. 16–17).

Costa, E., Bana, C. A., & Vansnick, J.-C. (1994). Macbeth an interactive path towards the construction of cardinal value functions. *International transactions in operational Research*, *1*(4), 489–500.

FAO. (2007). *The state of the world's animal genetic resources for food and agriculture*. Rome: Commision on genetic resources for food and agriculture, FAO.

Groeneveld, E., Westhuizen, B., Maiwashe, A., Voordewind, F., Ferraz, J., et al. (2009). Poprep: a generic report for population management. *Genetics and Molecular Research*, *8*(3), 1158–1178.

Price, B., Kienast, F., Seidl, I., Verbrug, P., Ginzler, C., & Bolliger, J. (2013). Spatially explicit modelling of land-use suitability and future land-use pattern for switzerland. In *Abstract volume, 11th geoscience meeting - computational giscience.*