

The Swiss feed database a GIS-based analysis platform

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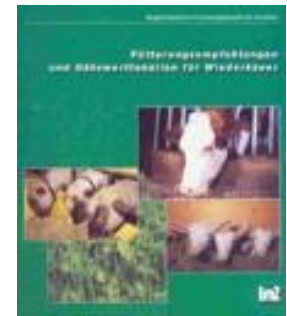
Outline

- Milestones
- Data sources
- Data curation
- Interactive web application: query concept
- Result views
 - Summary data
 - Geo-referenced Detail Data: interacting windows
 - Visualization options: Google Map, Kernel density function
 - Detail Data: spatial patterns in hay quality using Kernel regression
 - Detail Data: spatial patterns in barley – a particularity for Cu
 - Detail Data: time trends, importance of chemical analysis method
 - Advanced data analysis: one-to-many region comparison
- Conclusion

Milestones

1979

Print versions of the Feeding Recommendations and Feed Tables for Ruminants and Pigs



1991 - 2004

2007

Online version of the Swiss Feed Database: Nutrients for more than 600 raw materials and roughage for ruminants, pigs, horses and poultry (mean values)

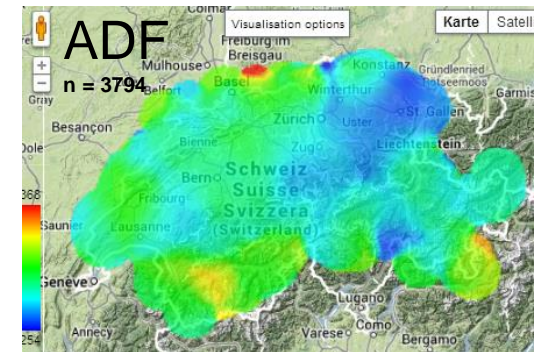
Aliment	MA [g/kg MS]	MG [g/kg MS]	CB [g/kg MS]	NDF [g/kg MS]	ADF [g/kg MS]	sucres [g/kg MS]
G prairie riche en graminées, autres que ray-grass, stade 4, sec	123.0	35.0	278.0	514.0	312.0	86.0
G prairie riche en graminées, autres que ray-grass, stade 5, sec	101.0	35.0	315.0	578.0	346.0	83.0
GR prairie riche en graminées, surtout en ray-grass, stade 3, sec	134.0	35.0	239.0	441.0	269.0	128.0
GR prairie riche en graminées, surtout en ray-grass, stade 4, sec	119.0	35.0	253.0	466.0	285.0	124.0
E prairie équilibrée, stade 3, sec	146.0	35.0	238.0	430.0	276.0	89.0

2010 - 2014

Thesis: Managing Time-Varying Measurement Sets in Databases

2013

Launch of the temporal data warehouse: interactive web interface enriched with visual tools



Data sources

❖ Research and Surveys: Agroscope, Universities

■ Feeding trials



■ Conservation



■ Plant breeding



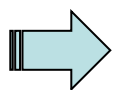
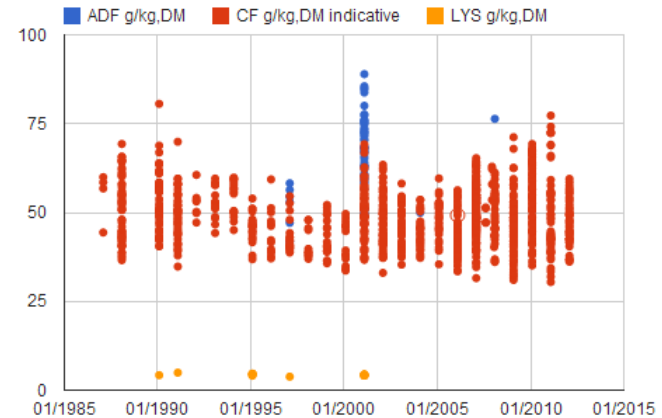
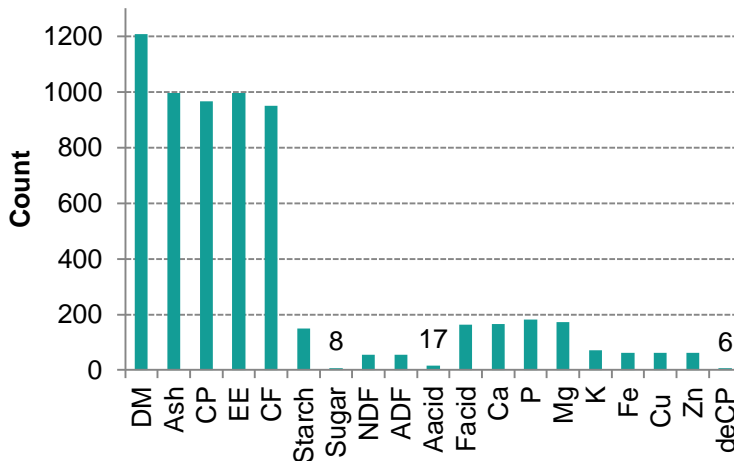
❖ Farms, Feed industry: yearly hay survey, raw materials

❖ Publications, Feed Databases: INRA, CVB, DLG, ARC, NRC

Data curation

The main challenge: feed data is often incomplete and irregular (sometimes sparse) in time, space (origin) and available nutrients

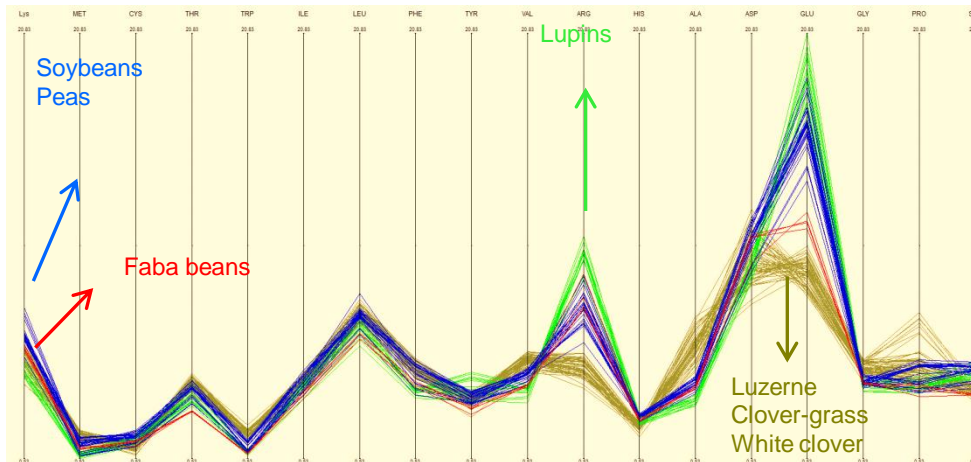
Count and temporal pattern of chemical analyses in barley samples



Abundant proximate analysis, sparse fiber fractions, amino acids, trace elements
Aggregated nutrients need to be balanced for coherence and representativeness

Imputation of aggregated nutrients

Amino acid profiles of legume seeds



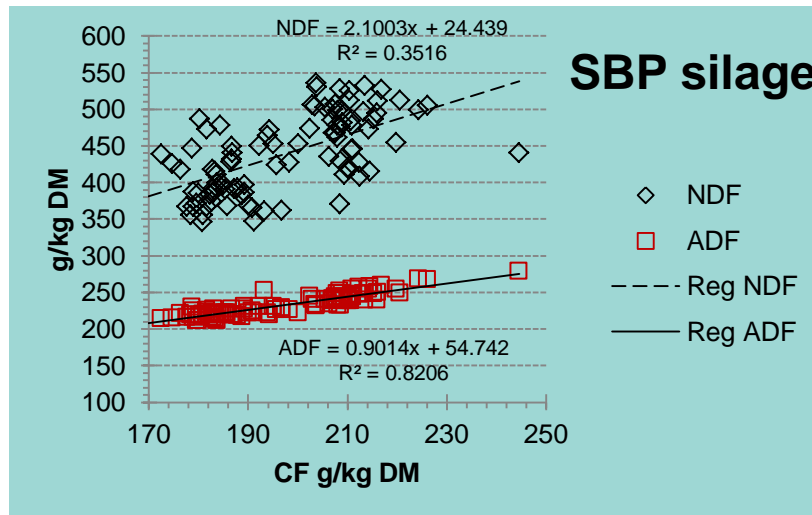
Pre-condition:

characteristic, multivariate pattern (profile) → fingerprint

Example:

Quantification of amino acids based on the **amino acid profile** (g AA/g CP)

$$\text{Lys g/kg} = [\text{avg g Lys/g CP}] * \text{CP}$$



Pre-condition:

Correlated nutrients → regression

Example:

Regression technique to adjust mostly fiber fractions to the mean crude fiber content. High and rather low correlations co-exist.

$$\text{ADF g/kg DM} = 0.9014 * \text{CF} + 54.742$$

(SBP silage)

Interactive web application: query concept

Search parameters for summary data or detail data

- organized into a row of buttons, each button one search category
- an overlay window displays search options by a list, tree or map
- are loaded dynamically based on the already chosen options

The screenshot shows the FEED BASE web application interface. The main navigation bar includes the logo for FEED BASE (Schweizerische Eidgenossenschaft, Confédération suisse, Confederazione Svizzera, Confederaziun svizra) and the Agroscope logo. Below the logo, there are links for home, info, feeding recommendations, applications, and feedback. A user is logged in as 'subscriber (logout)' and the language is set to 'deutsch - français - english'. The main search bar contains several buttons: Detail Data, Summary Data, Feed Type (8/22), Nutrients (11/224), Time (0/34), Geo (0/24), Biology, and Technique. A search icon is also present.

Four overlay windows are shown, each connected to a button in the main search bar:

- Feed Type:** A list of raw materials and roughage options, including Cereal grains, Cereal co-products, Oil seeds and co-products, Tubers and roots, products and co-products, Legume seeds, Fruits and co-products, Other plants and co-products, Feed of animal origin, Oils and fats, Mineral feed, Additives, Food industry co-products, and SCP (Single Cell Protein).
- Nutrients:** A list of nutrients and nutritive values, including Nutrients, Ruminants, Digestibility, degradability (ruminants), Energy value (ruminants), Milk production potential, Protein value (ruminants), Structure value, Fattening calves, Pigs, Bacterially fermentable matter, Digestible phosphorus (pigs), Energy value (pigs), Ileal digestible amino acids, Nutrient digestibility (pig), Pig apparent ileal digestibility of amino acids, Poultry, and Horses.
- Time:** A time selection window with a Year list (1987-1996) and a Season list (Spring, Autumn, Summer, Winter, n/a).
- Geo:** A geographical selection window with a map view. The map shows a region around Bern, Switzerland, with a red circle indicating a selected area. The map includes labels for various locations like Solothurn, Bern, Thun, Lausanne, and Morges. The map also shows a radius of 10km and a search bar with the address 1725.

Result views: Summary Data

Curated, aggregated nutrients on a dry matter or as fed basis, with export function

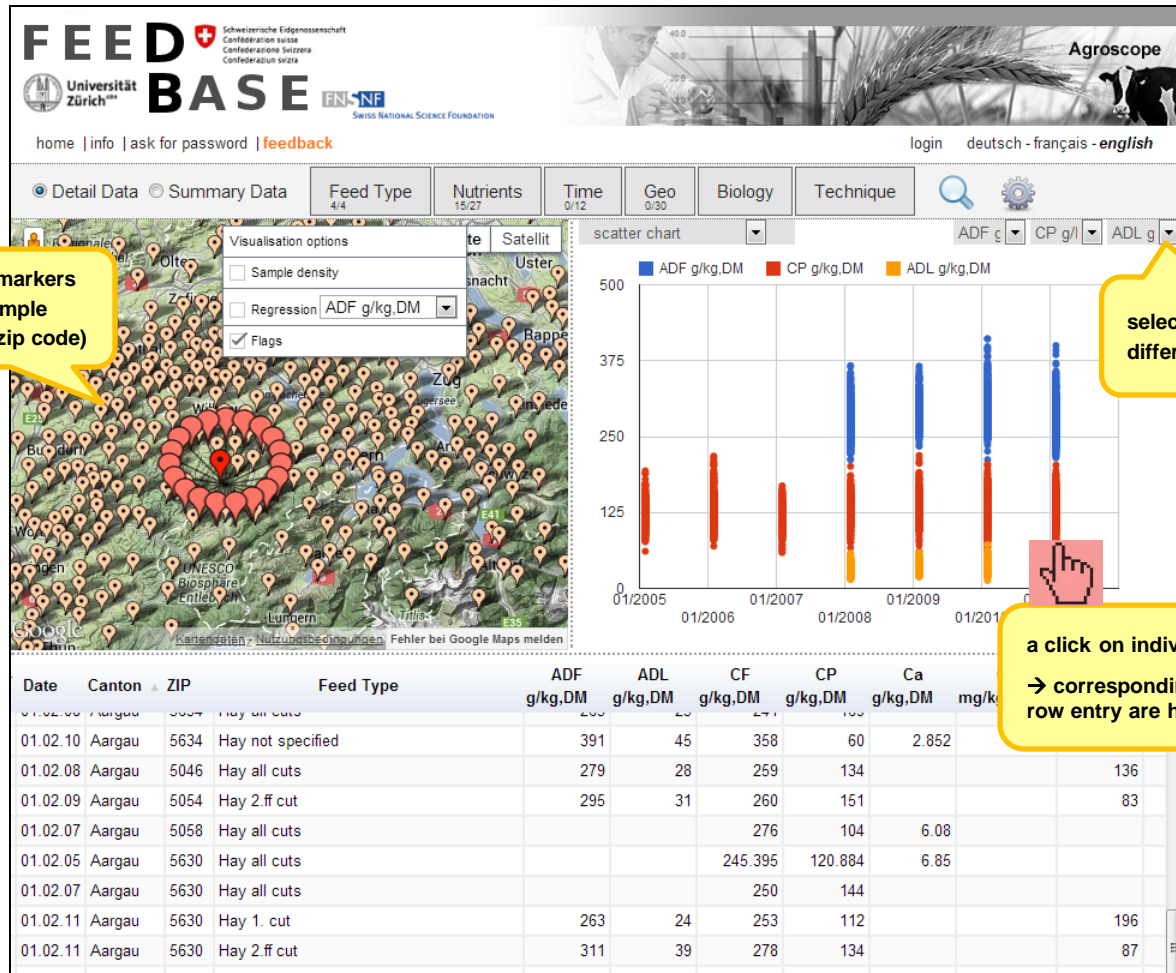
The screenshot shows the FEED BASE web application interface. At the top, there are logos for the Swiss National Science Foundation, Universität Zürich, and Agroscope. The main navigation bar includes 'home', 'info', 'feeding recommendations', 'applications', and 'feedback'. Below this, there are tabs for 'Detail Data' and 'Summary Data', and a 'Feed Type' dropdown menu. The main content area is a table of nutrients with columns for various nutrient types (DM, OM, Ash, CP, EE, CF, NIE, Ca, P, F) and their units. A callout box points to a column heading, stating 'a click into any column heading sorts the table in ascending or descending order'. Another callout box points to a nutrient field, stating 'a click into a nutrient field expands a window with additional information'. A third callout box points to a user profile icon, stating 'save query options as user defined top query'. An expanded window for 'Maize, grains (Com)(lat. Zea mays)' is shown, displaying details such as 'Feed: 11', 'Parameter name: Phosphorous', 'Formula: 0.7native', 'Not rounded value: 3.2663', 'Authors Notes: Median', 'Modification date: 30.5.2013', 'Number of values: 60', and 'Standard deviation: 0.281'. The footer of the application includes '© Universität Zürich, Agroscope, 2011-2013' and a 'Disclaimer' link.

	DM g/kg	OM g/kg,DM	Ash g/kg,DM	CP g/kg,DM	EE g/kg,DM	CF g/kg,DM	NIE g/kg,DM	Ca g/kg,DM	P g/kg,DM	F mg/kg,D
22 Horse bean (field Vicia faba)	870	958.865	41.135	295.999	17.769	94.84	550.3	1.6	7.21	58
23 Lard	995	1000	0	0	1000	0	0	0	0	0
24 Maize, kernels (lat. Zea mays)	900	966.57	33.43	358.69	67.34	152.36	388.2	2.325	4.708	39
25 Maize, meal (lat. Zea mays)	900	960.21	39.79	396.09	94.05	126.75	343.7	0.2	0.2	4
26 Maize, starch	890	966	34	116	75	58	7	0	0	0
27 Maize, gluten (lat. Zea mays)	900	990.39	9.61	89.735	29.645	15.633	855	0.2	0.2	4
29 Maize, kernel silage	650	986.04	13.96	91.392	44.373	18.887	831	0.2	0.2	4
30 Maize starch	890	999	1	4.3	3	2	989.7	0.2	0.2	4
31 Maize, grains (Com)(lat. Zea mays)	870	985.027	14.973	96.343	47.163	19.294	822.2	0.04217	3.266	18
32 Milling by-product mixture	870	949.8	50.2	179.395	51.421	81.14	637.9	1.1	0.7	131
33 Oat feed meal	900	970	30	146	76	71	677	0.65	4.869	63
34 Oats flakes (lat. Avena sativa)	890	978.42	21.58	151.39	70.54	14.19	742.3	0.51771	0.2	0.2
35 Oats grains, dehulled (lat. Avena sativa)	870	973.59	26.41	134.482	54.301	89.224	695.6	1.05	0	0
36 Oats, grains (lat. Avena sativa)	870	970.559	29.441	119.413	50.386	118.784	682	0.81649	0.2	0.2
37 Outgrowth wheat grains (lat. Triticum aestivum)	870	981.77	18.23	147.75	16.554	22.288	795.2	0.45272	0.2	0.2
38 Palm oil (lat. Elaeis guineensis)	999	1000	0	0	1000	0	0	0	0	0
39 Pea, seeds (lat. Pisum sativum ssp)	870	966.52	33.48	227.584	19.12	64.214	655.6	0.92958	0.2	0.2
40 Peanut oil (ground-nut oil)	1000	1000	0	0	1000	0	0	0	0	0
41 Potato peelings	150	944	56	110	7	47	780	2.4	0.2	0.2
42 Potato protein	900	963.33	36.67	833.51	24.662	4.921	100.2	1.11	0.2	0.2
43 Potato starch	830	996.03	3.97	2.032	1.519	2.397	990.1	0.2	0.2	0.2
44 Rapeseed oil	1000	1000	0	0	1000	0	0	0	0	0

Result views: geo-referenced Detail Data

Query results displayed in 3 interacting windows: map, chart (+statistic), sortable list

Query result based on the hay survey



Visualization options: Google Maps, Kernel density function

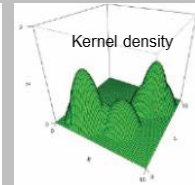
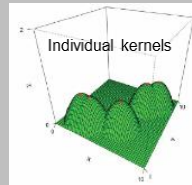
Latitude and longitude of individual samples based on zip code



Computation of the two-dimensional **density estimation** using bivariate Kernel function. Conversion of the density value into color values ranging from blue=low to red=high density.

$$\hat{f}_h(x, y) = \frac{1}{nh^2} \sum_{i=1}^n K\left(\frac{x - X_i}{h}, \frac{y - Y_i}{h}\right)$$

$$h_{opt} = \sigma * A(K) * n^{-\frac{1}{6}}$$



Where K = Bivariate Epanechnikov Kernel

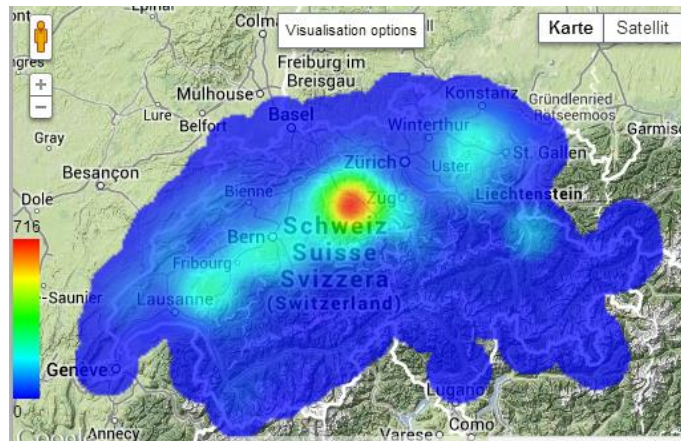
$$K(x, y) = \begin{cases} \frac{2}{\pi}(1 - x^2 - y^2), & \text{if } x^2 + y^2 < 1 \\ 0, & \text{otherwise.} \end{cases}$$

h = bandwidth (smoothing factor)
x, y = coordinates

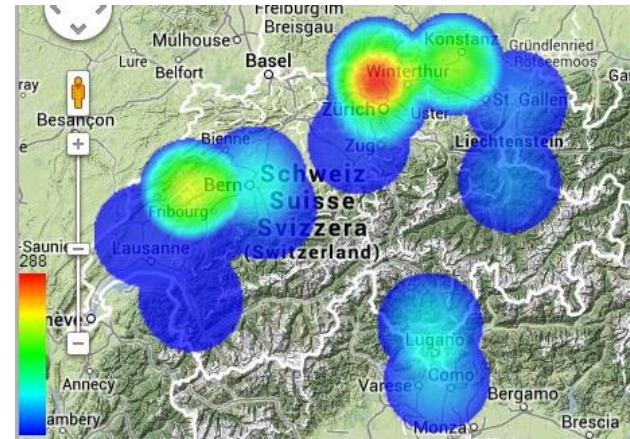
Limited visual possibilities with markers

Sample density: color scale dynamically generated for each selected data set

Hay survey: countrywide sample distribution



Maize grains: regional sample distribution

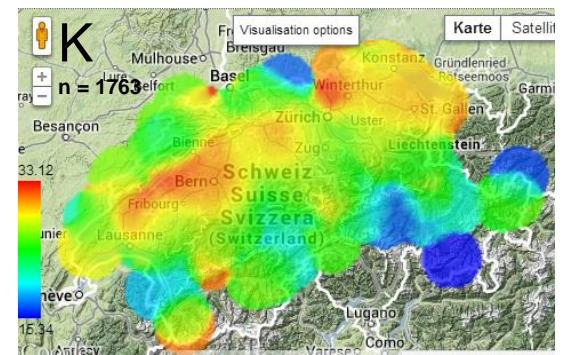
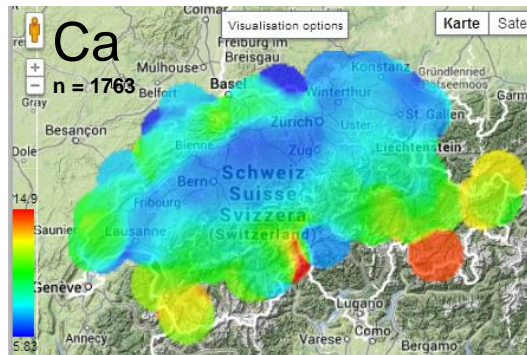
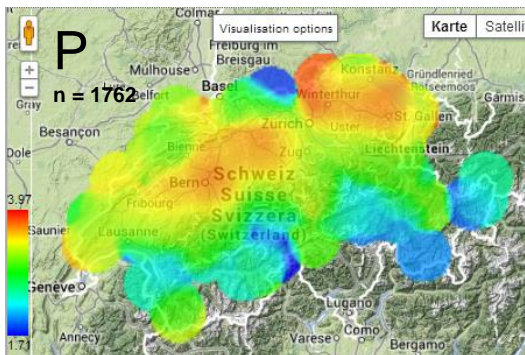
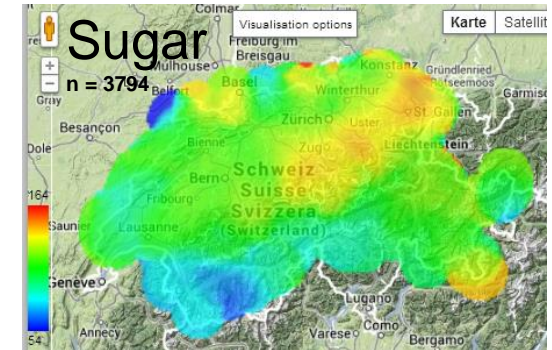
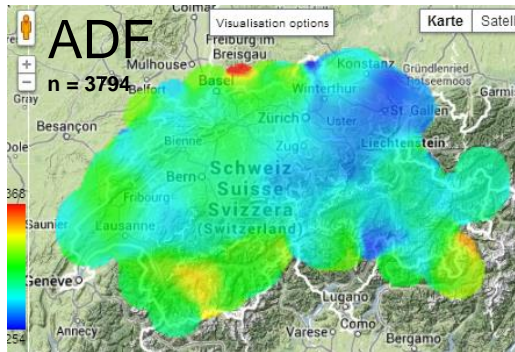
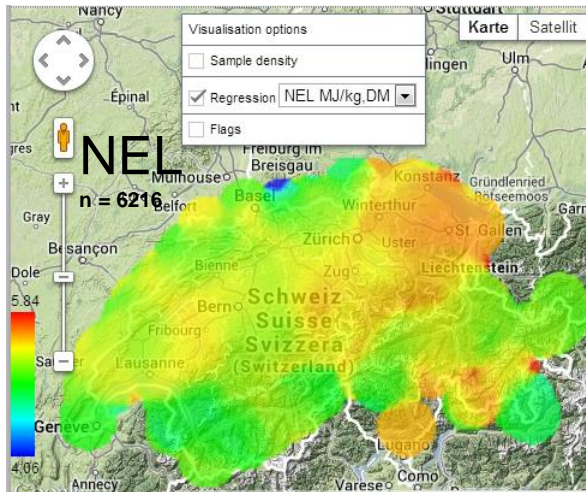


Spatial patterns in hay quality (Kernel regression)

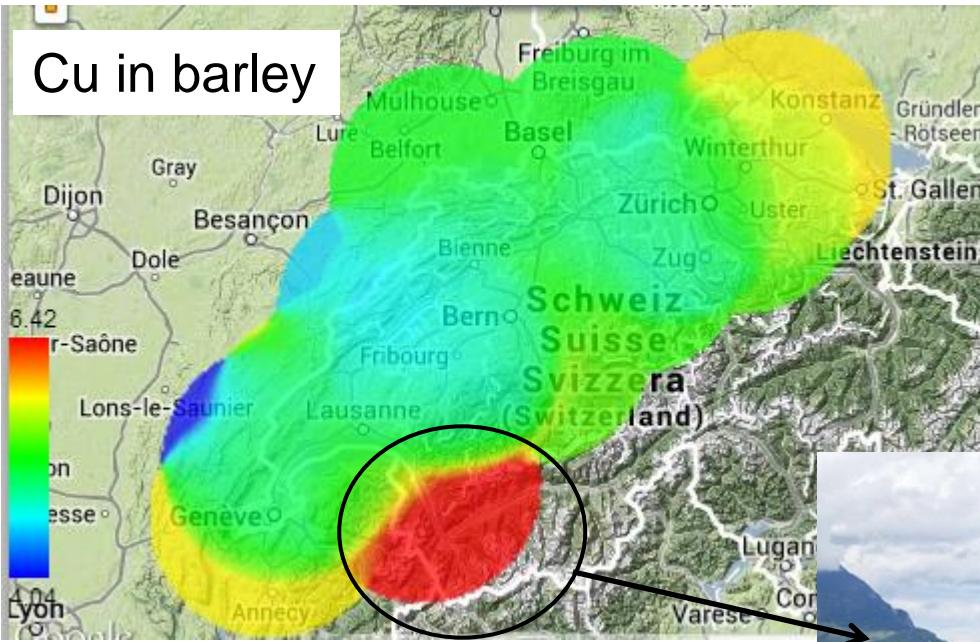
The nutrient density at the location (x,y) is:

$$\hat{g}_h(x, y) = \frac{\sum_{i=1}^n K\left(\frac{x - X_i}{h}, \frac{y - Y_i}{h}\right) Q_i}{\sum_{i=1}^n K\left(\frac{x - X_i}{h}, \frac{y - Y_i}{h}\right)}$$

Reliable interpretation with >1000 locations

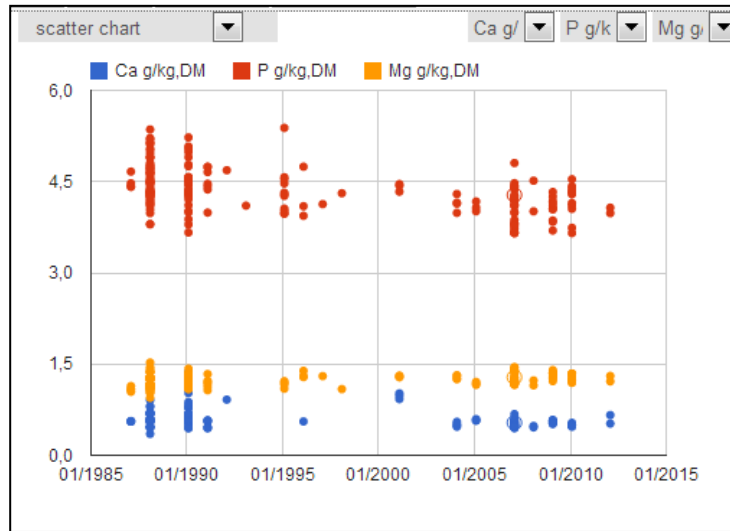


Spatial pattern in barley: local effects on Cu



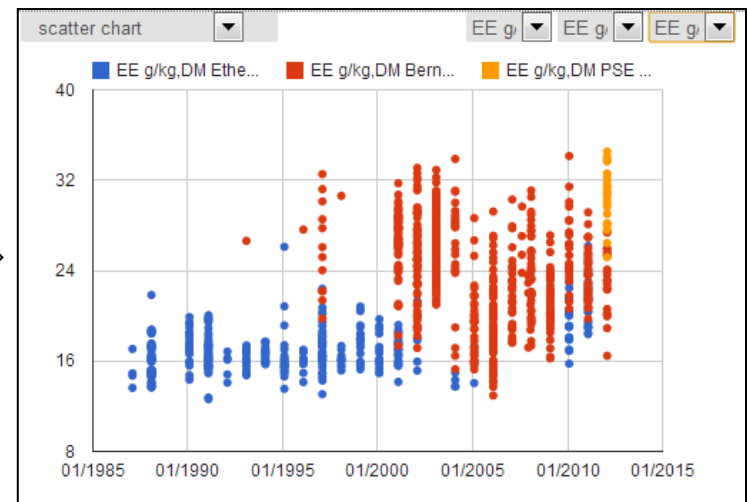
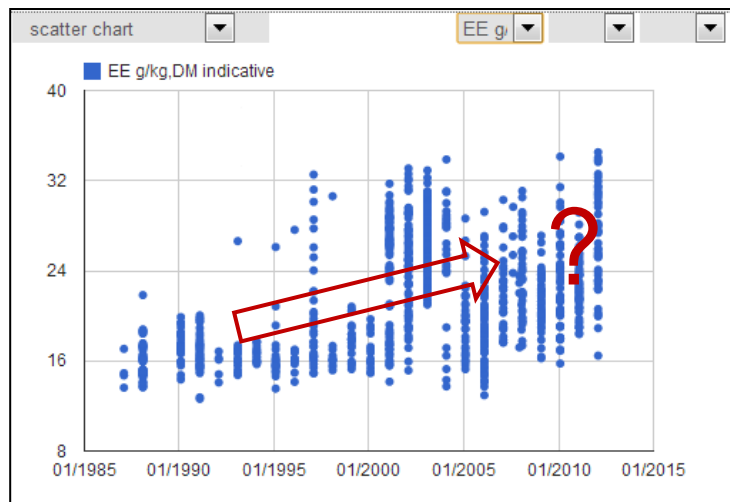
Wind drift from vineyards?

Temporal analysis in barley: minerals, fat

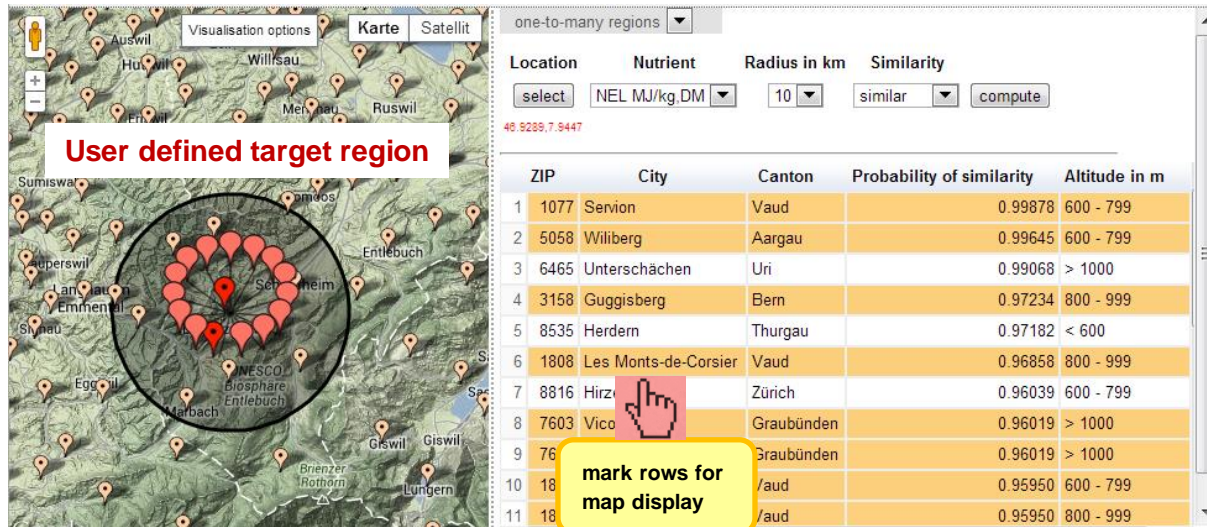


Decreasing P content in barley
1988/1990: 4.5 g P/kg DM
>2000: 4.1 g P/kg DM

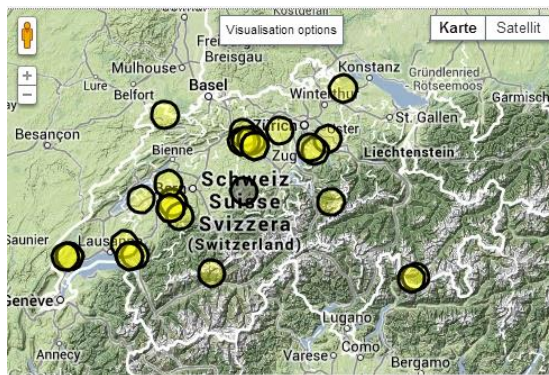
Change in chemical analysis



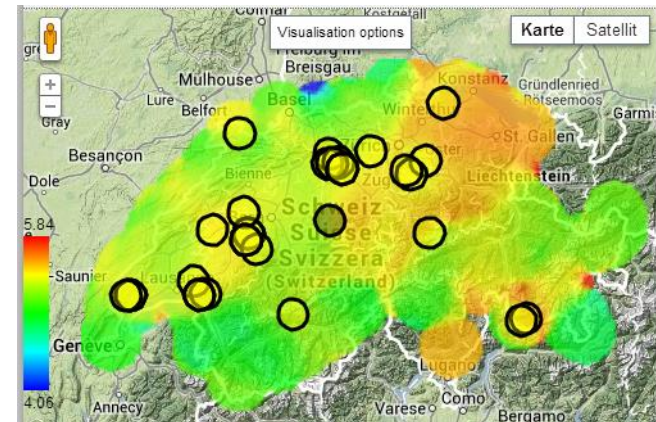
Advanced data analysis: region comparison



Top 30 most similar regions



Top 30 ... with nutrient density (NEL) in the background



Conclusions

- Recent developments of the online Swiss feed database support intuitive and advanced data analysis down to individual samples based on visual tools.
- Scatter plots visualize temporal patterns or trends and show the full extent of variation.
- As a novel approach, spatial patterns in nutrient density (concentration) are generated for large, geo-referenced data sets using the Kernel regression technique. There is strong evidence for regional influence on feed quality. The hay survey indicates an east-west and mountain-lowland divide with respect to energy, fiber, sugar and mineral content.
- Summary data and detail data are complementary views of defined feed types assembling spatio-temporal information with categorical attributes (i.e. botanical composition)
- For further discovery: www.feedbase.ch