

Stefan Siebert (Crop Science Group, University of Bonn, Germany)

Survey based agronomic statistics and their application for land and water usage quantification

- Why using survey data?
- Challenges / pitfalls
- How to implement survey data
- Combination with other data

Introduction
Why using survey data?

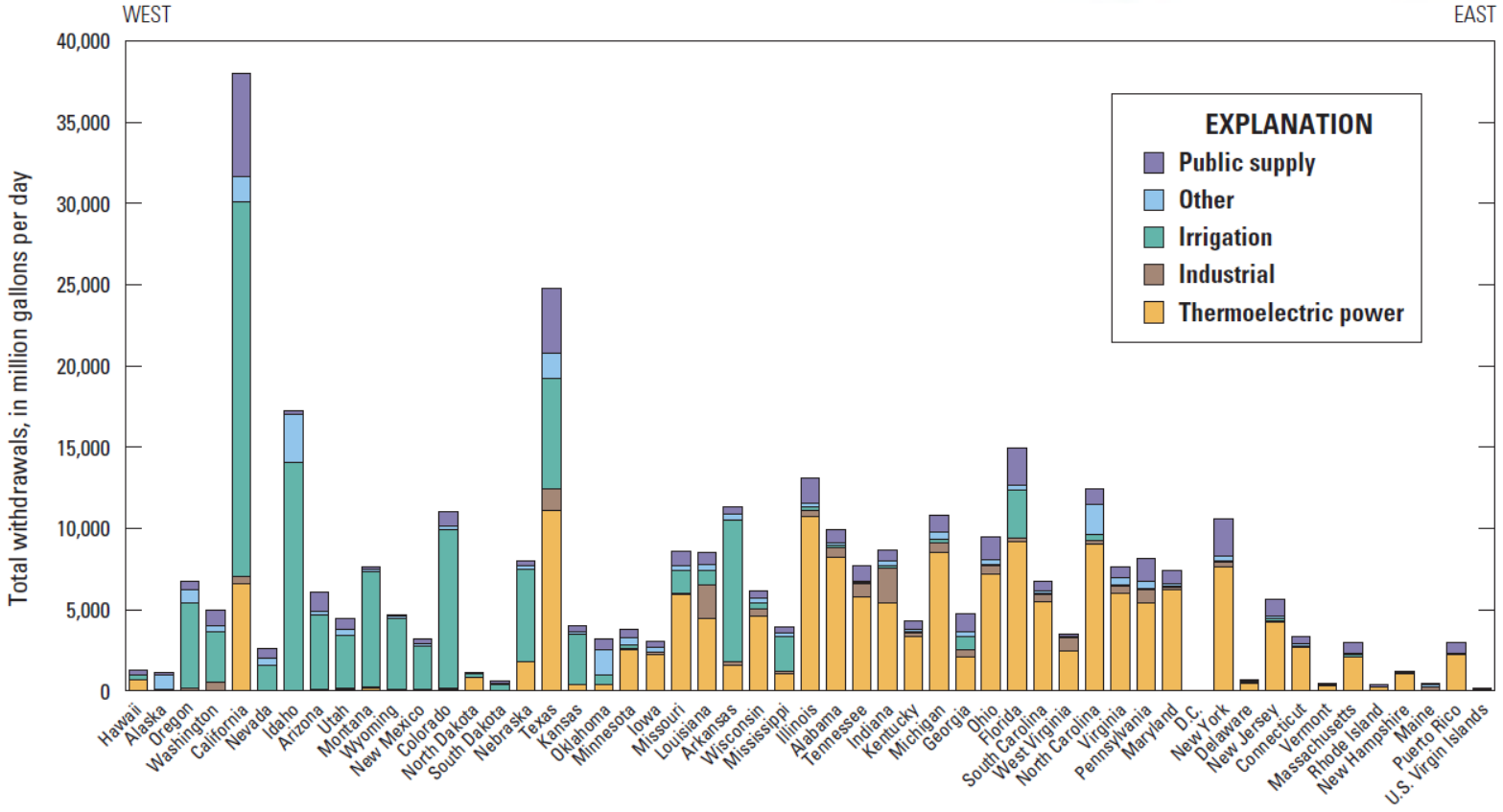
- In most of the countries surveys or censuses are undertaken in regular time steps
- A lot of information is available on agriculture, environment, economy, water use
- Data are reported for specific administrative units (states, provinces, districts …)

→ spatial data

Crop Science Bonn universitätbonn

USGS science for a changing world

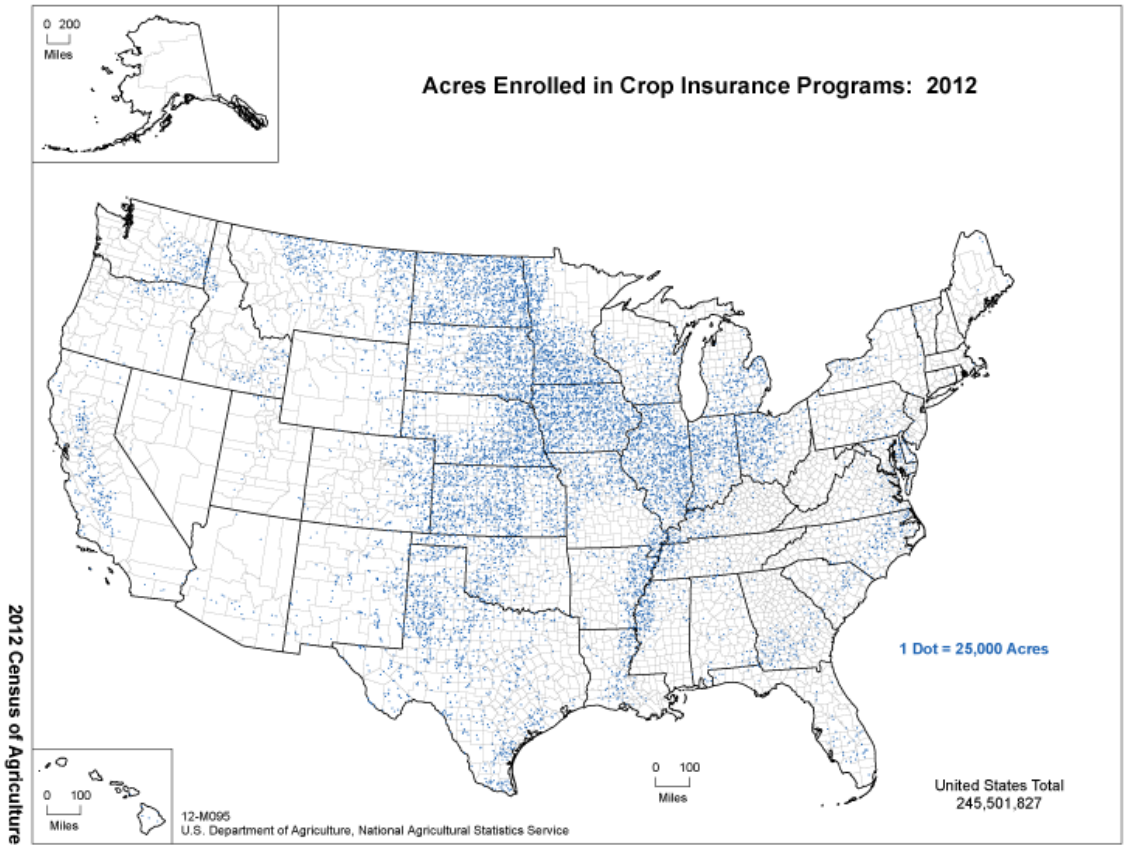
Estimated Use of Water in the United States in 2010



Access to data that are difficult to measure or observe in the field

2012 CENSUS OF AGRICULTURE

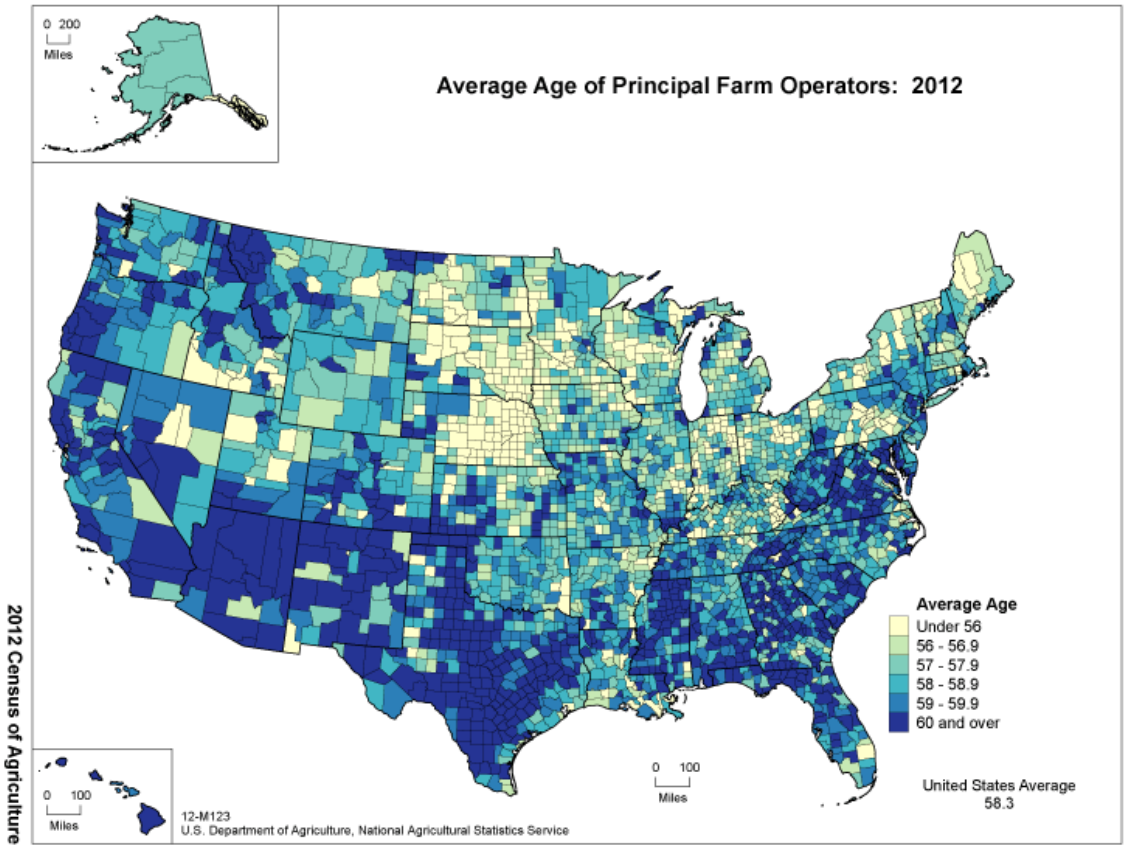
- Crops and Plants
- Economics
- Farms
- Livestock and Animals
- Operators



Crop Science Bonn universitätbonn

2012 CENSUS OF AGRICULTURE

- Crops and Plants
- Economics
- Farms
- Livestock and Animals
- Operators



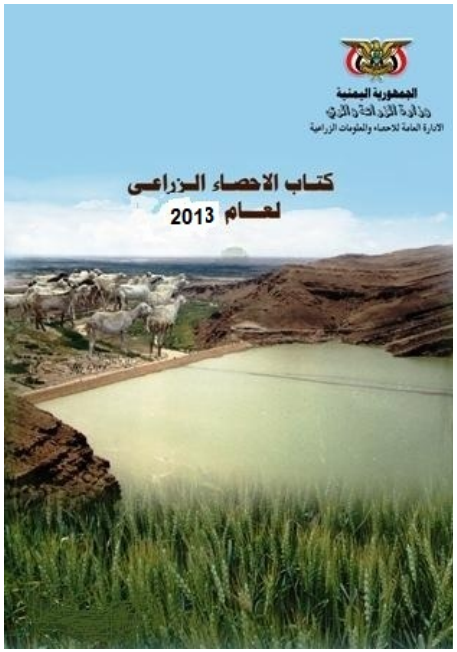
Access to ancillary information to support modeling of water use and management

Challenges / pitfalls

Challenges / pitfalls
Terms and definitions differ!

Crop Science Bonn universitätbonn

Republic of Yemen - Agricultural Statistics Yearbook 2013



عدد الحائزين الزراعيين والمساحات الكلية والصالحة والمحصولية حسب مصادر الري لعام 2013م

المساحة)هكتار(

Governorates	Crops Area By soures Irrigation							المساحة المحصولية	المساحة الصالحة	المساحة الكلية	عددالحائزين الزراعيين	المحافظات	المسلسل
	اخرى Other	ماء منقول بالسيارة Tank on Car	سدود وحواجز Dams	غيول streams	سيول Floods	آبار wells	أمطار Rains	Crops Area المساحة المحصوليه	Cultivatble المساحة الصالحة	Total.Area المساحة الكلية	No of Agri. Holders عددالحائزين الزراعيين		
AL-Hodeidah	355	4,251	10,627	9,565	56,680	95,647	177,125	354,250	314,777	327,107	87,486	الحديده	1
Sana'a	175	2,096	5,239	4,715	27,942	47,153	87,320	174,640	136,596	144,900	88,905	صنعاء	2
Dhamar	125	1,504	3,759	3,383	20,049	33,832	62,652	125,304	103,296	113,734	111,969	ذمار	3
Ibb	102	1,222	3,054	2,749	16,288	27,486	50,901	101,802	53,224	56,445	177,614	اب	4
Taiz	86	1,044	2,610	2,349	13,920	23,489	43,499	86,997	58,117	64,067	155,505	تعز	5
Mareb	42	520	1,300	1,170	6,931	11,696	21,659	43,318	88,886	116,592	14,450	مأرب	6
Hajjah	136	1,633	4,082	3,674	21,773	36,741	68,039	136,078	136,815	147,076	98,292	حجه	7
AL-Baida	36	438	1,096	986	5,844	9,861	18,262	36,523	69,520	74,956	34,778	البيضاء	8
Sa'adah	44	530	1,324	1,192	7,062	11,918	22,070	44,140	40,721	50,726	49,113	صعده	9
AL-Mahweet	31	379	947	852	5,049	8,520	15,778	31,556	21,726	27,443	44,698	المحويت	10
Lahej	37	447	1,117	1,006	5,960	10,058	18,625	37,250	26,390	31,804	55,570	لحج	11
Abyan	45	530	1,326	1,193	7,070	11,931	22,095	44,190	60,757	65,071	28,449	أبين	12
Hadramout	48	581	1,454	1,308	7,753	13,083	24,227	48,454	51,715	54,422	40,159	حضرموت	13
AL- Jawf	50	609	1,523	1,371	8,122	13,706	25,381	50,762	90,972	109,245	28,638	الجوف	14
Shabwah	26	306	766	690	4,087	6,896	12,771	25,542	49,373	58,524	22,578	شبوه	15
AL-Maharah	2	35	87	79	466	786	1,456	2,911	3,368	3,973	3,467	المهره	16
Aden	2	17	43	38	227	384	710	1,421	2,834	3,013	516	عدن	17
Amran	106	1,249	3,123	2,811	16,659	28,112	52,059	104,119	107,098	121,487	69,395	عمران	18
AL-Daleh	16	190	474	426	2,527	4,265	7,898	15,796	14,009	15,089	36,680	الضالع	19
Sana'a City	7	87	217	195	1,157	1,952	3,615	7,230	8,725	9,317	7,725	الامانه	20
Raimeh	28	325	814	732	4,339	7,323	13,560	27,121	13,519	14,493	35,994	ريمة	21
Total	1,499	17,993	44,982	40,484	239,905	404,839	749,702	1,499,404	1,452,438	1,609,484	1,191,981	الإجمالي	

Definition of "irrigated area" or "groundwater" differs considerably across countries

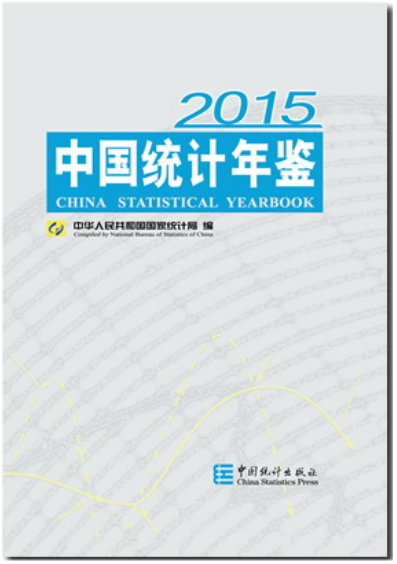
Challenges / pitfalls

Terms and definitions differ!

中华人民共和国国家统计局 编
Compiled by National Bureau of Statistics of China

CHINA STATISTICAL YEARBOOK 2015

China Statistics Press



12-5 Irrigated Area of Cultivated Land and Consumption of Chemical Fertilizers

Year / Region	Irrigated Area of Cultivated Land (1 000 hectares)	Consumption of Chemical Fertilizer (10 000 tons)	Nitrogenous Fertilizer	Phosphate Fertilizer	Potash Fertilizer	Compound Fertilizer
1978	44965.0	884.0				
1980	44888.1	1269.4	934.2	273.3	34.6	27.2
1985	44035.9	1775.8	1204.9	310.9	80.4	179.6
1990	47403.1	2590.3	1638.4	462.4	147.9	341.6
1995	49281.2	3593.7	2021.9	632.4	268.5	670.8
2000	53820.3	4146.4	2161.5	690.5	376.5	917.9
2005	55029.3	4766.2	2229.3	743.8	489.5	1303.2
2006	55750.5	4927.7	2262.5	769.5	509.7	1385.9

"Irrigated area is the sum of watered fields and irrigated fields where irrigation systems or equipment have been installed for regular irrigation purpose."

TABLE 10
Irrigation by major river basin in Mainland China in ha (Source: MWR, 2007/2006/2005)

Food and Agriculture Organization of the United Nations

AQUASTAT Home

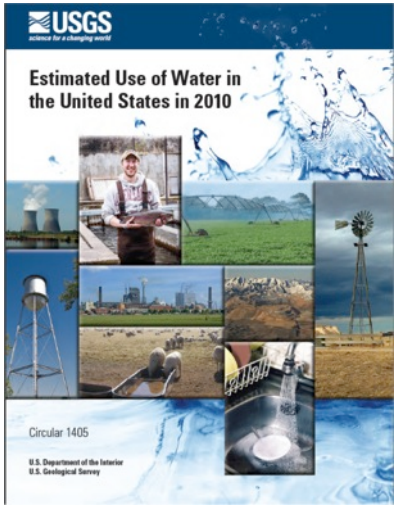
River basin	Total area equipped for irrigation	Annual crops (effective irrigation)*	Forests	Orchards	Pasture	Other	Actually irrigated total (part of 2)	Actually irrigated annual crops (part of 3)	Actually irrigated other (part of 4+5+6+7)
[1]	[2]=[3+4+5+6+7]	[3]	[4]	[5]	[6]	[7]	[8]=[9+10]	[9]	[10]
Total 2006	62 559 130	57 078 400	1 562 150	1 988 650	1 201 170	728 760	53 892 399	49 024 490	4 867 909
Total 2005	61 897 940	56 562 360	1 636 610	1 860 940	1 172 020	666 010	52 758 103	47 968 730	4 789 373
Total 2004	61 511 150	56 252 070	1 573 310	1 862 460	1 184 990	638 320	52 251 258	47 783 880	4 467 378

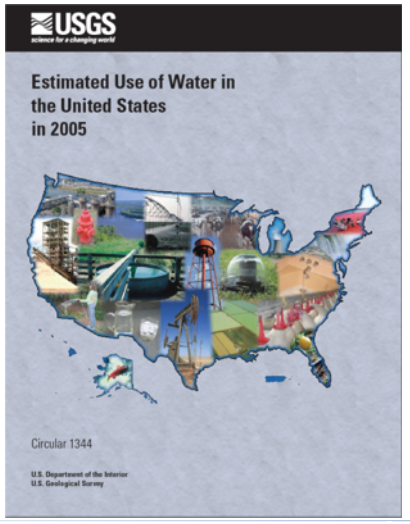
* In China, irrigation of annual (food) crops is called "effective irrigation"

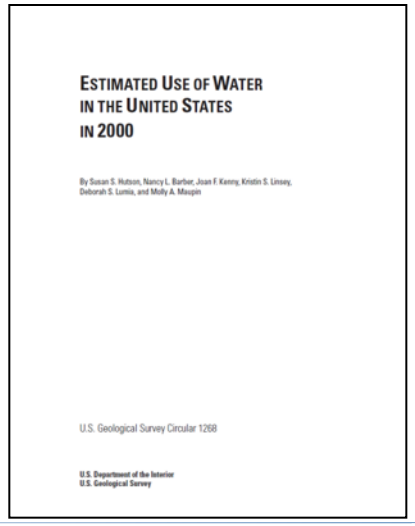
Area equipped for irrigation underestimated by 7 Mha (10%) in FAO data until 2012 because the irrigated area derived from the statistical yearbook of China excluded pasture, orchards and forests

Challenges / pitfalls

Different source – different data!



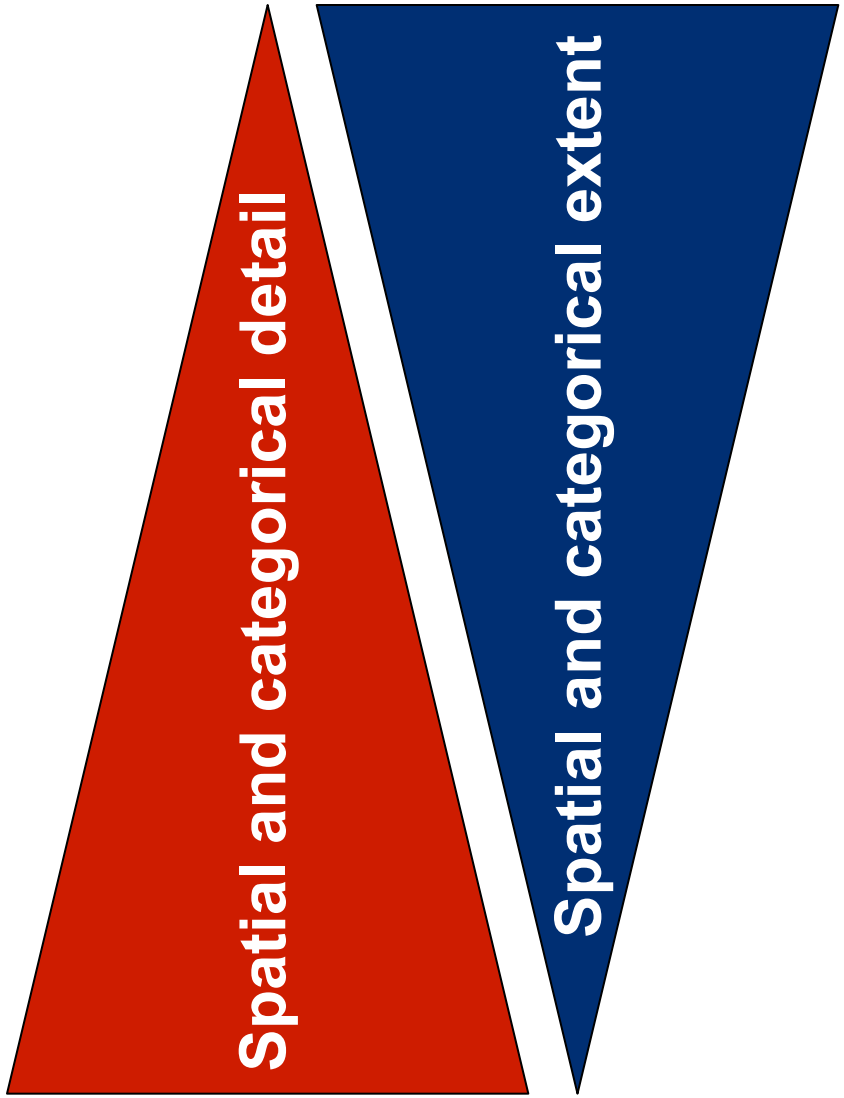




- Different institutions
- Different reference years
- Different sampling strategies
- Different results, e.g. for irrigated areas

Challenges / pitfalls

Different source – different data!



UNdata
A world of information

FAOSTAT

aquastat

European Commission
eurostat
Your key to European statistics

DESTATIS
Statistisches Bundesamt

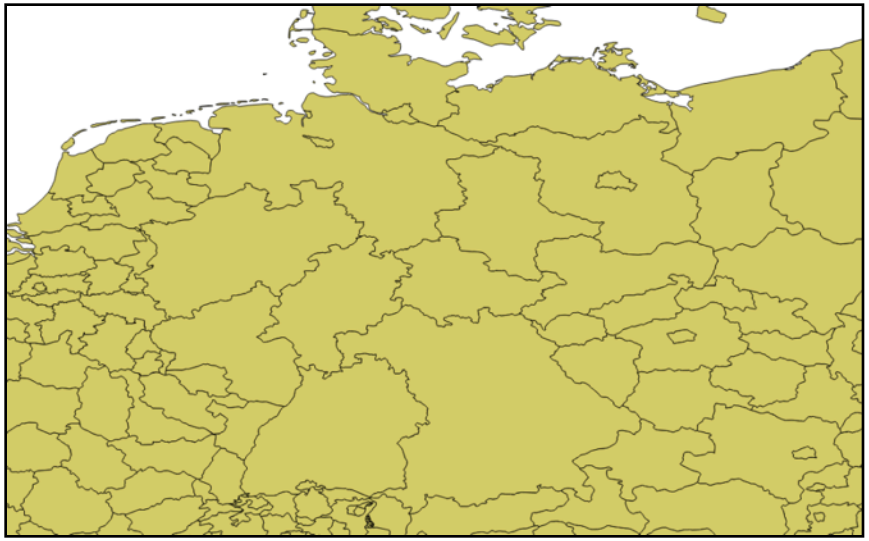
LDB
Landesdatenbank NRW

Flow of information (reporting)

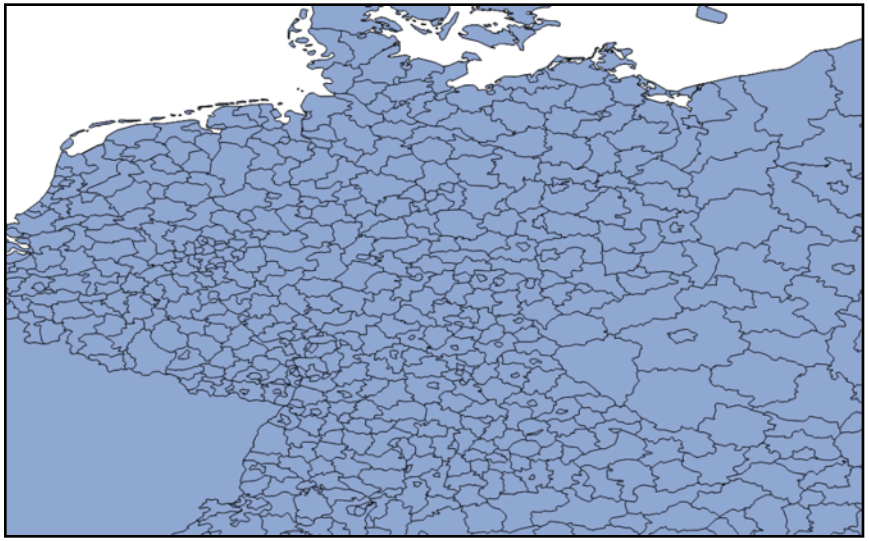
Challenges / pitfalls

Different source – different data!

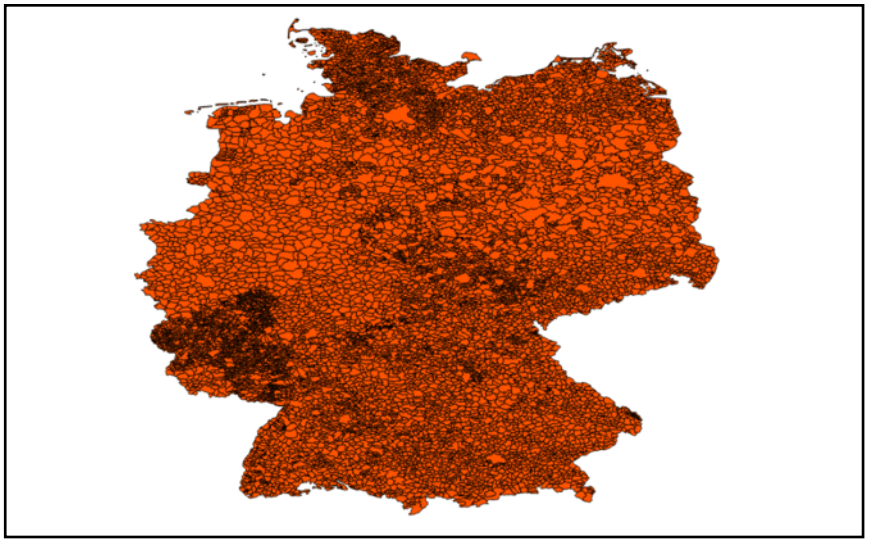
National Statistical Office



Eurostat - GISCO



Statistical Offices of the German federal states



=> Depending on the data provider, the spatial resolution of the statistics may be limited to country level, state level, NUTS3 (Eurostat) or municipality level (statistical agencies of subnational units such as federal states).

Challenges / pitfalls
Different source – different data!

Data at high resolution often contain missing data (values confidential or unknown)

Australian Bureau of Statistics

Water Use on Australian Farms, 2005-06: Estimates for Local Government Areas

Released at 11.30am (Canberra time) Fri 12 September 2008

Table 1: Total water use

Region	Agricultural businesses (Number)	Agricultural businesses - Annotation	Irrigation volume applied (Megalitres)	Irrigation volume applied - Annotation	Other agricultural uses (Megalitres)	Other agricultural uses - Annotation	Total water use (Megalitres)	Total water use - Annotation
Tumut Shire (A)	383		6297		1736		8032	
Tweed (A)	663		2806		1584	^	4390	
Unincorporated ACT	99		784	^	439		1224	^
Unincorporated NSW	147		n.p.	*	n.p.		3461	^
Unincorporated NT	283		7587	^	14857		22444	
Unincorporated SA	216		n.p.	^	n.p.		5922	
Unincorporated Vic	20		n.p.	^	42	^	n.p.	^
Unley (C)	2	*	n.p.	^	—		n.p.	^
Upper Gascoyne (S)	21		n.p.	*	n.p.		893	
Upper Hunter Shire (A)	717		31225		4792		36017	
Upper Lachlan (A)	1017		1772	^	5219		6991	
Uralla (A)	295		n.p.		n.p.		3484	
Urana(A)	149		23461		1311		24771	
Victor Harbor (C)	148		3186		791		3976	

Contents | Table 1 | Table 2 | Table 3 | Explanatory Notes

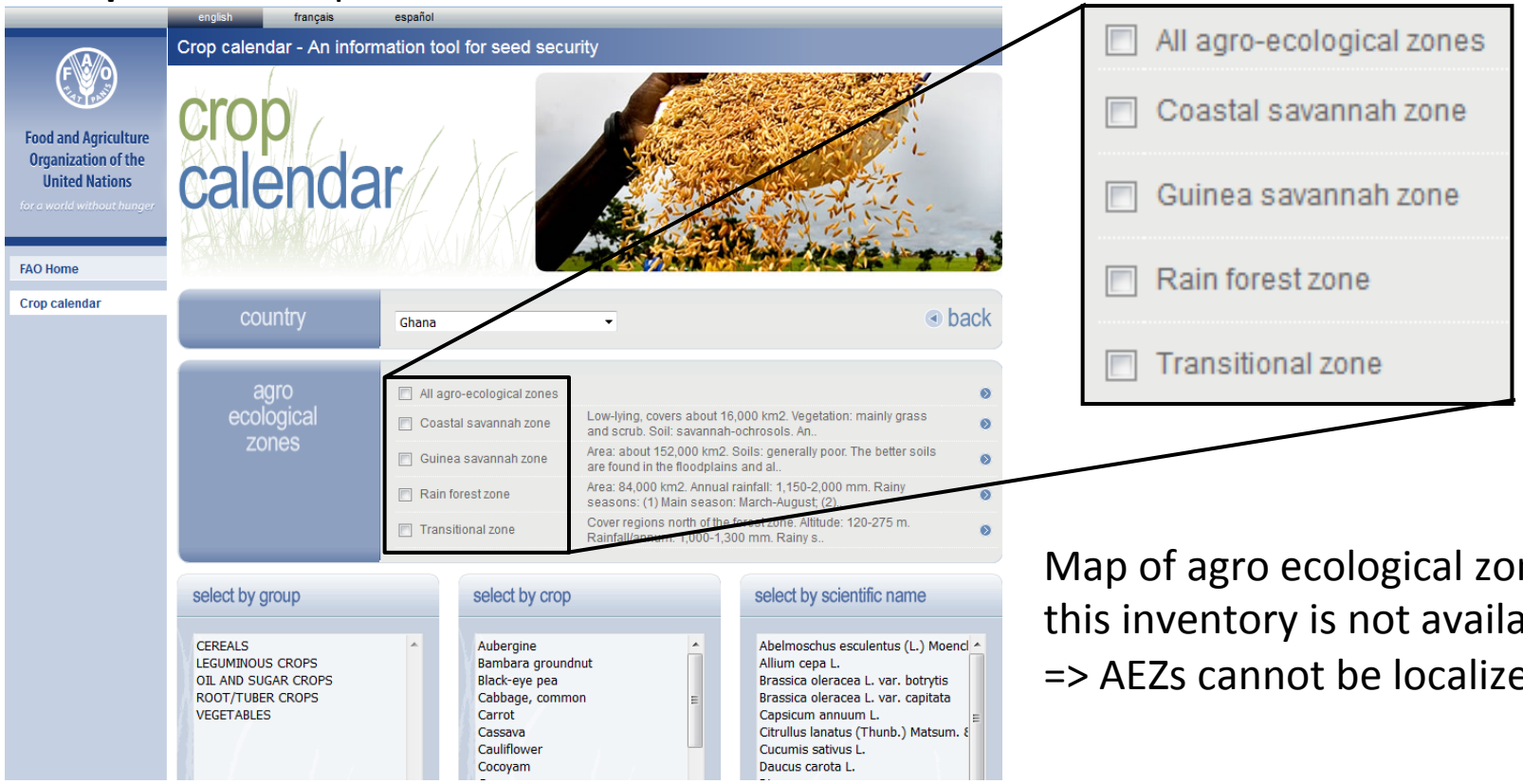
To achieve complete coverage, missing values need to be estimated => uncertainties

Challenges / pitfalls
Administrative unit boundaries

Survey data can only be mapped with consistent administrative unit boundaries but

most of the providers of survey data do not offer these geodata => mapping is not possible or needs external data that often are not consistent

Example: FAO crop calendar for Africa



Map of agro ecological zones used for this inventory is not available
=> AEZs cannot be localized

Challenges / pitfalls
Administrative unit boundaries

Survey data can only be mapped with consistent administrative unit boundaries

Global Administrative Areas

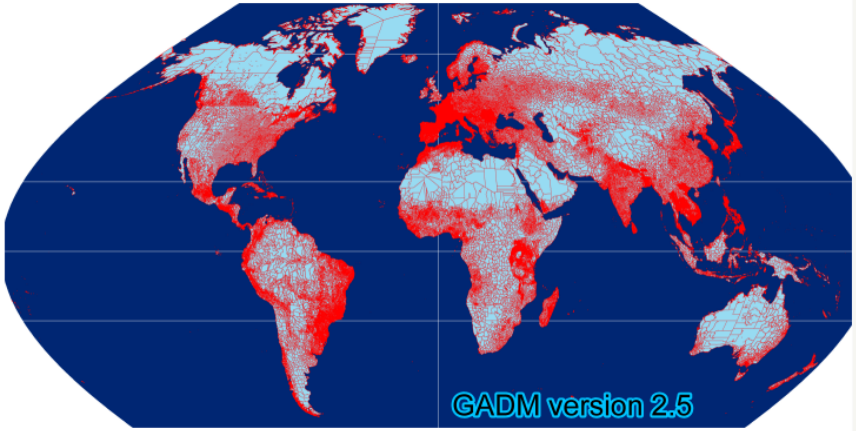
Boundaries without limits

Download | Known problems | About | Contact

GADM database of Global Administrative Areas

GADM is a spatial database of the location of the world's administrative areas (or adminstrative boundaries) for use in GIS and similar software. Administrative areas in this database are countries and lower level subdivisions such as provinces, departments, bibhag, bundeslander, daerah istimewa, fivondronana, krong, landsvæðun, opština, sous-préfectures, counties, and thana. GADM describes where these administrative areas are (the "spatial features"), and for each area it provides some attributes, such as the name and variant names.

The current version is 2.7 (August 2015). The next version will be released in October.



The current version of GADM delimits 273,726 administrative areas.

The data are available as shapefile, ESRI geodatabase, RData, and Google Earth kmz format. Shapefiles can be used for most mapping and "GIS" software. You can download a free program such as Q-GIS or DIVA-GIS. The RData files can be used in *R* with the 'sp' package loaded.

You can **download the data by country** or for the whole whole world.

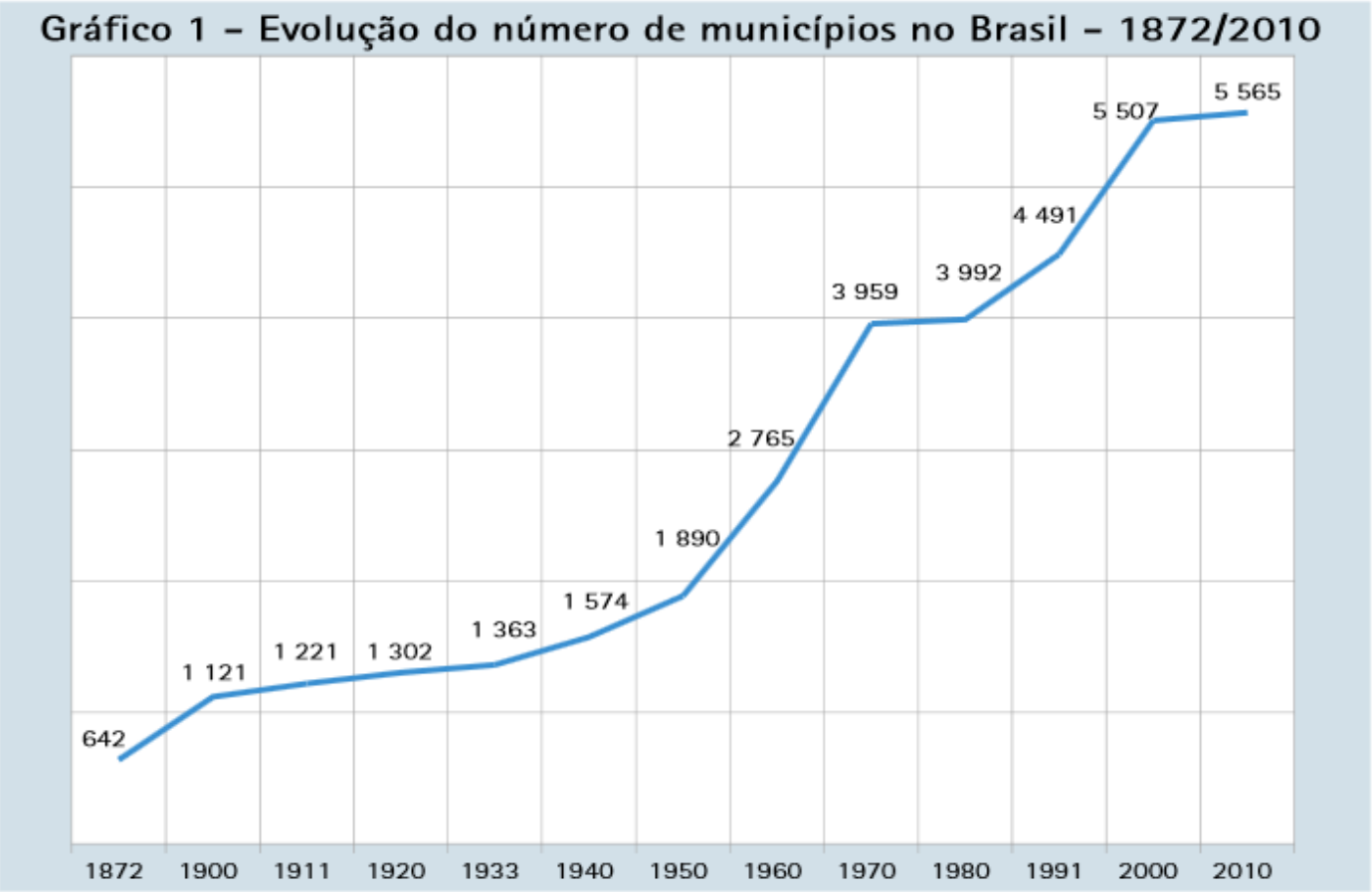
Various sources of administrative units available, but often inconsistent (due to varying precision in mapping, different reference years, different classifiers or names of administrative units)

294,430 administrative units in GADM, version 2.8

Refers to **recent administrative setting**

For global inventories often **60-80% of the workload** associated with fixing administrative unit boundaries!

The administrative setup of the nations is changing continuously!!!

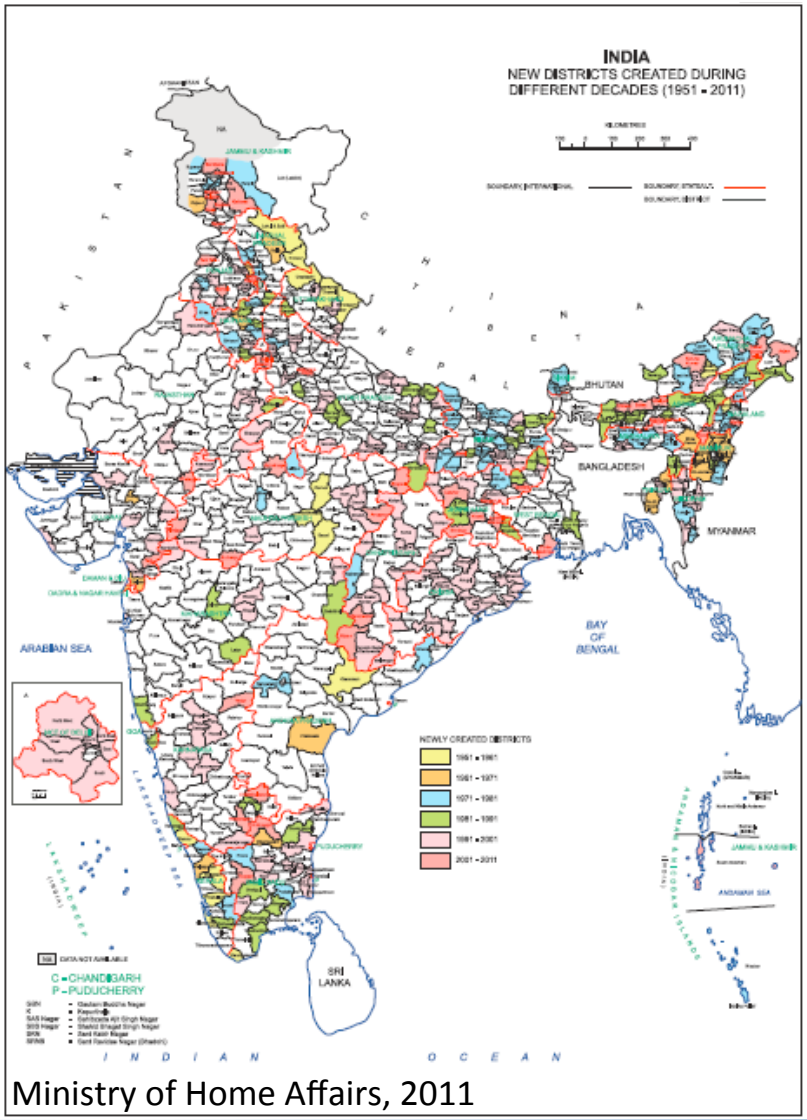


Fontes: Directoria Geral de Estatística, Recenseamento do Brazil 1872/1920 e Divisão Administrativa do Brasil 1911/1933; e IBGE, Censo Demográfico 1940/2010.

BRAZIL

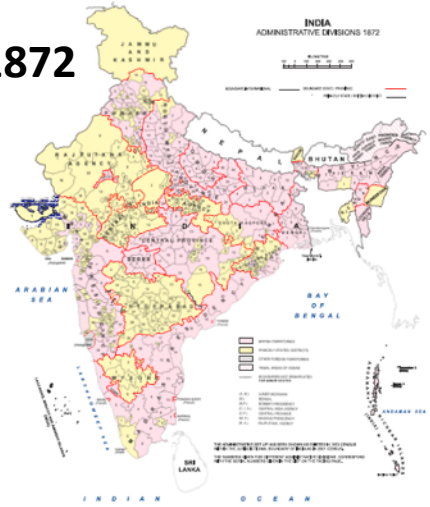
Challenges / pitfalls
Administrative unit boundaries

The administrative setup of the nations is changing continuously!!!



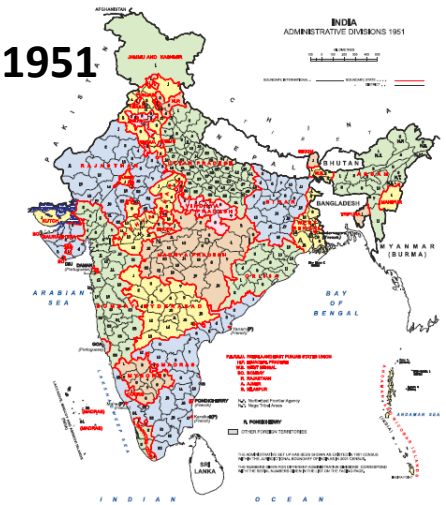
Ministry of Home Affairs, 2011

1872



15 states, 379 districts

1951



29 states, 310 districts

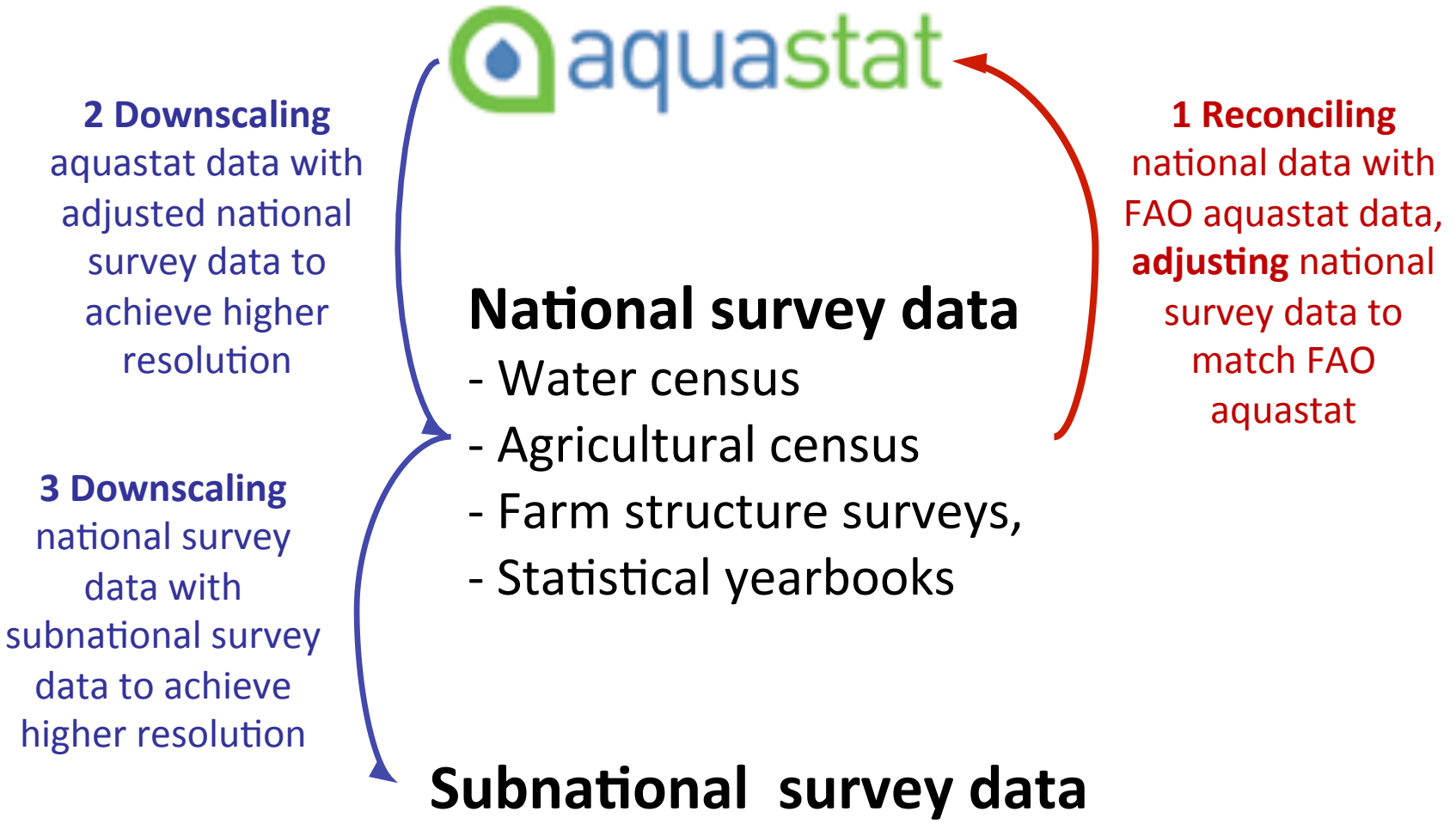
INDIA

2011

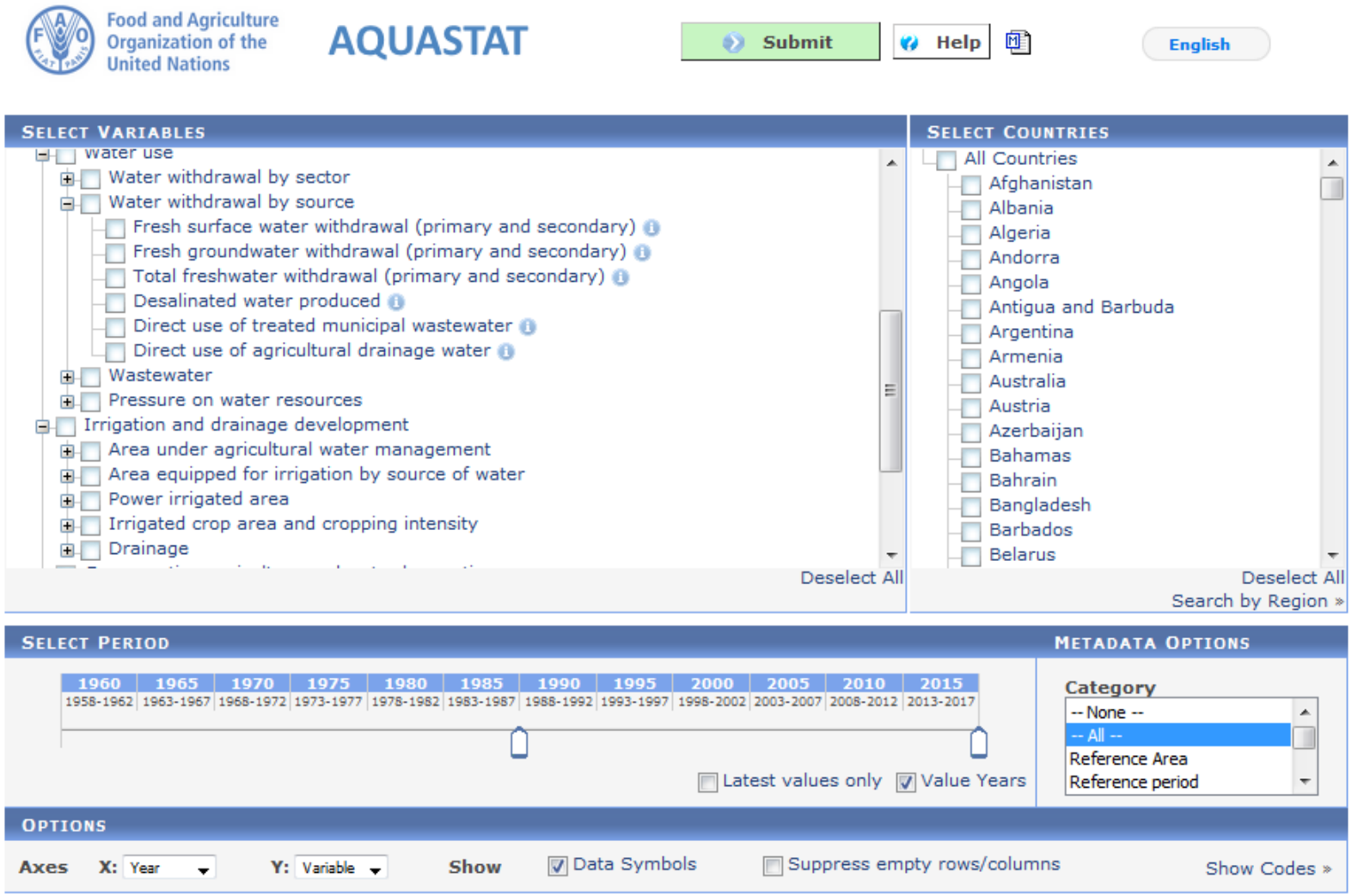
35 states, 640 districts

Recommendations on how to compile global / continental data bases based on survey data

How using survey data?
Large extent + high resolution



How using survey data?
Large extent + high resolution

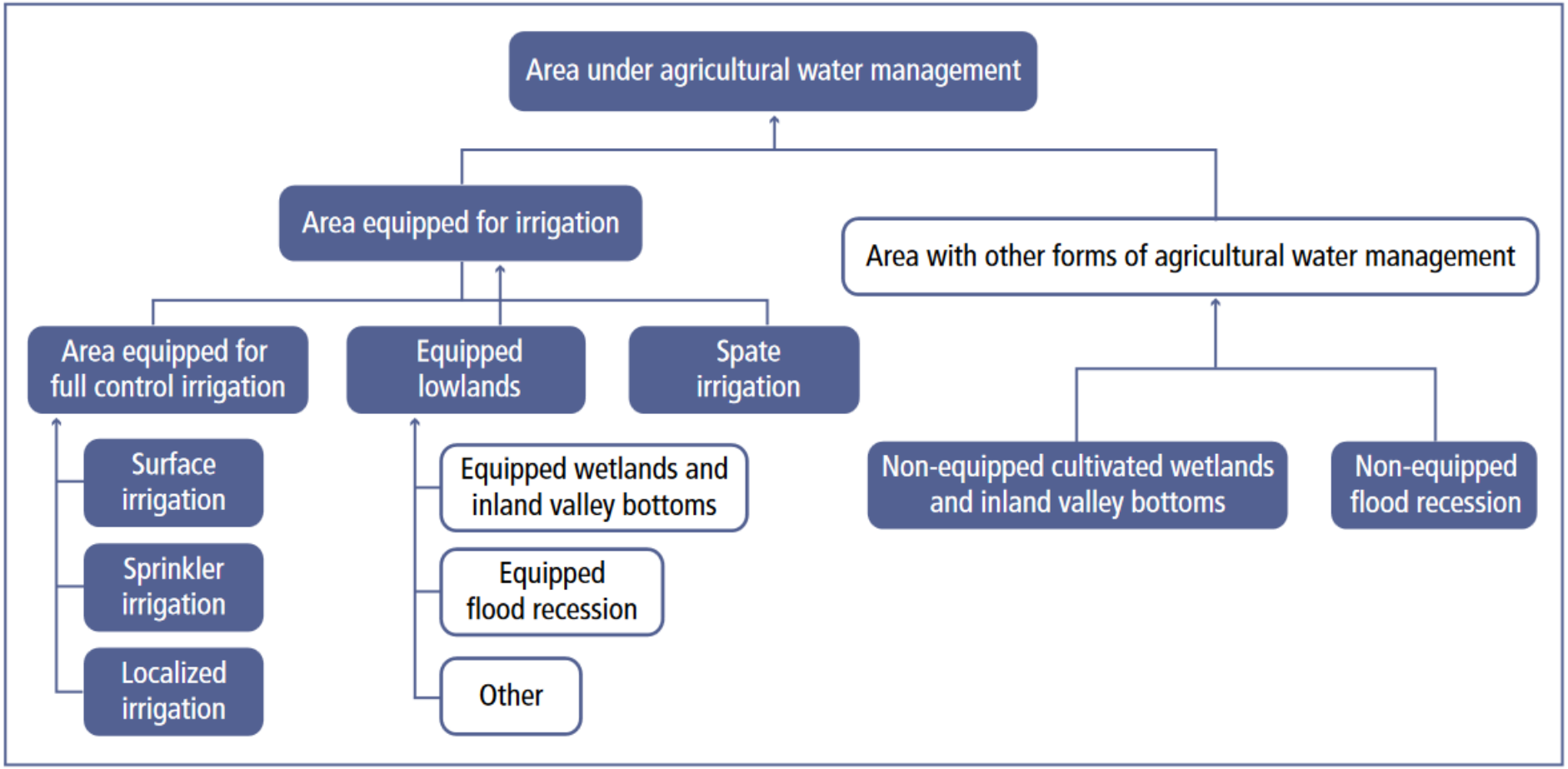


National statistics selected and adjusted to match FAO terminology => consistent

How using survey data?
Large extent + high resolution

Food and Agriculture Organization of the United Nations

AQUASTAT



National statistics selected and adjusted to match FAO terminology => consistent

Example: FAO classification of irrigated areas => e.g. rainfed wetland rice and water harvesting not included in area equipped for irrigation

Crop Science Bonn universitätbonn

Replacing FAO aquastat country data with consistent subnational data

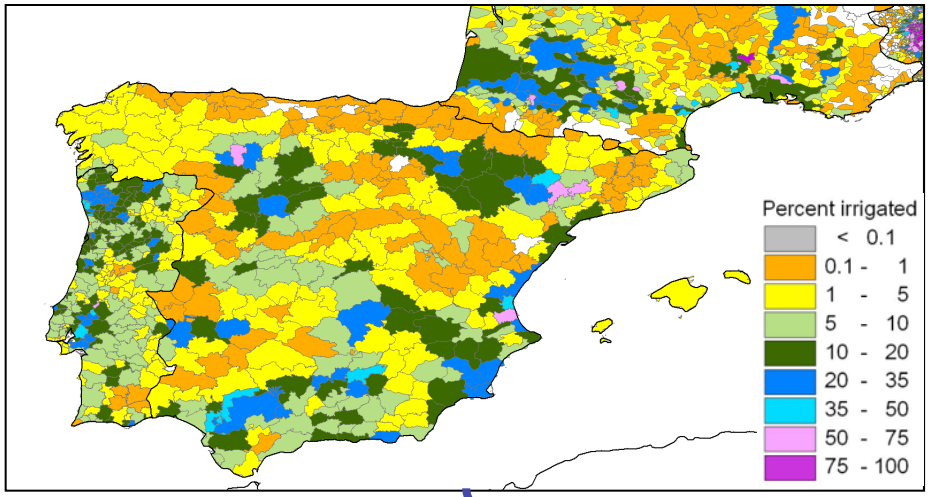
1) Translating terms and definitions
2) Fixing inconsistencies
3) Incorporation of subnational data

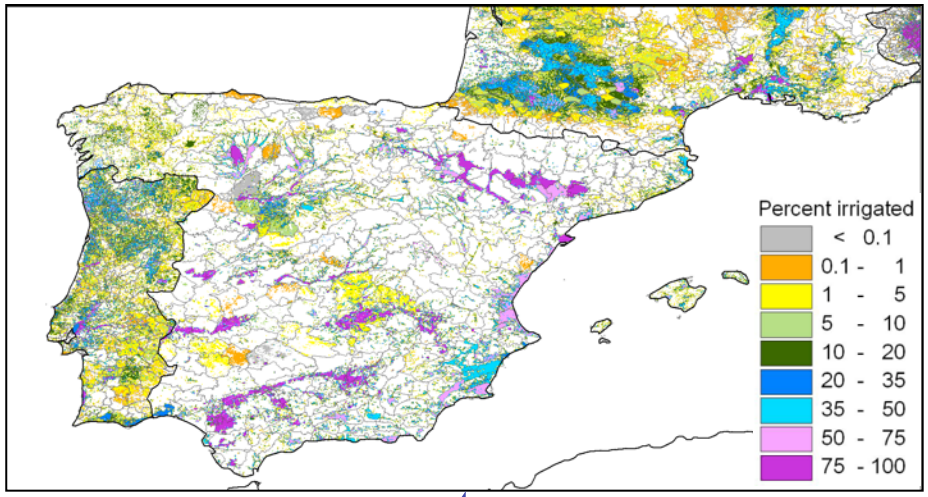
Example: translating terms and definitions between FAO aquastat and Eurostat

FAO aquastat		**Eurostat**
Area equipped for irrigation	⟷	Area irrigable
Area actually irrigated	⟷	Area irrigated at least once in a year
Irrigation with groundwater	⟷	Irrigation with on-farm groundwater
Irrigation with surface water	⟷	Irrigation with on-farm surface water + Irrigation with off-farm surface water
Irrigation with water from mixed sources	⟷	Irrigation with off-farm water from water supply networks + Irrigation with water from other sources

Downscaling to pixel level by data fusion of survey based inventories and other spatial data

Combination with other data
From district to pixel level





- Combination with other spatial data derived by remote sensing (=> next talk) or mapped at the ground
- Different approaches are being used (rule based, Bayesian …)
- Depending on the intended use of the data, consistency to different input data can be maximized (to survey data, to remote sensing classifiers, to both)

Thanks for your attention!!!