June 20, 2007

Global Agricultural Land Use Data for Climate Change Analysis

by

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Book chapter prepared for inclusion in:

Economic Analysis of Land Use in Global Climate Change Policy

Editors: Tom Hertel, Steven Rose, Richard Tol

Publisher: Routledge

Background and Introduction

The Center for Sustainability and the Global Environment (SAGE) at the University of Wisconsin has been developing global databases of contemporary and historical agricultural land use and land cover. SAGE has chosen to focus on agriculture because it is clearly the predominant land use activity on the planet today, and provides a vital service—i.e., food—for human societies. SAGE has developed a "data fusion" technique to integrate remotely-sensed data on the world's land cover with administrative-unit-level inventory data on land use (Ramankutty and Foley, 1998; Ramankutty and Foley, 1999; Ramankutty et al., in press). The advent of remote sensing data has been revolutionary in providing consistent, global, estimates of the patterns of global land cover. However, remote sensing data are limited in their ability to resolve the details of agricultural land cover from space. Therein lies the strength of the ground-based inventory data, which provide detailed estimates of agricultural land use practices. However, inventory data are limited in not being spatially explicit, and these data are also plagued by problems of inconsistency across administrative units. The "data fusion" technique developed by SAGE exploits the strengths of both the remotely-sensed data as well as the inventory data.

Using SAGE's methodology, Ramankutty, Evan, Monfreda and Foley (in press)—REMF hereafter—developed a global dataset of the world's agricultural crop and grazing lands for the period around 2000 (Figure 1). This was accomplished by combining national and sub-national agricultural inventory data and satellite–derived land cover data. The agricultural inventory data, with much greater spatial detail than previously available, is used to train a land cover classification dataset obtained by merging two different satellite-derived products. By utilizing the agreement and disagreement between Boston University's MODIS global land cover product and the GLC2000 dataset, the authors are able to predict the spatial pattern of agricultural land better than by using either dataset alone, and for the first time, statistical confidence intervals are provided with these estimates.

In previous work, Ramankutty and Foley (RF, 1999) compiled historical inventory data on cropland areas to extend the global croplands dataset back to 1700. RF also derived a global dataset of potential natural vegetation (PNV) types; this dataset describes the spatial distribution of 15 natural vegetation types that would be present in the absence of human activities. Furthermore, global datasets of the world's grazing lands and built-up areas (not shown), representative of the early 1990 period, were also developed recently (National Geographic Maps, 2002; Foley *et al.*, 2003). Leff *et al*. (2004) disaggregated the RF98 dataset to derive the spatial distribution of 19 crop types of the world (18 major crops and one "other crop" type and this was the basis for the version 1 GTAP-AEZ database, released in December, 2005. This database underpins a number of the CGE applications presented in Part III of this book.

The SAGE datasets described above are being used for a wide array of purposes, including global carbon cycle modeling (McGuire *et al*., 2001), analysis of regional food security (Ramankutty *et al.*, 2002b), global climate modeling (Bonan, 1999; Brovkin et al., 1999; Bonan, 2001; Myhre and Myhre, 2003), and estimation of global soil erosion (Yang *et al.*, 2003). They also formed part of the BIOME300 effort, initiated by two core projects—LUCC (Land Use and Land Cover Change) and PAGES (Past Global Changes) of the International Geosphere-Biosphere Programme (IGBP). In other words, they are a widely recognized, and widely used dataset of global agricultural land use.

Since the release of the version 1 GTAP-AEZ database, a much richer dataset – nick-named Agro-MAPS (FAO 2006b) – has become available. It was a joint project between the United Nations Food and Agriculture Organization (FAO), the International Food Policy Research Institute (IFPRI), and the Center for Sustainability and the Global Environment (SAGE). Agro-MAPS compiled global sub-national data on crop harvested areas, production, and yields for *ca*.

2000. Monfreda, Ramankutty and Foley (MRF, in press), combined the Agro-MAPS database with a number of national censuses and surveys to create an extensive database on crop areas and yields. They then fused this database with the global dataset of REMF for the year 2000 (Ramankutty et al., in press) to build a globally consistent land use database for crops which forms the basis for the version 2 release of the GTAP-AEZ database. This chapter summarizes their methods and a few salient findings. Readers interested in more detail are referred to the journal articles (Monfreda et al., in press and Ramankutty et al., in press). Since this new dataset has only become available shortly before the publication of this book, it is not used in any of the applications presented in Part III. However, it will no doubt form the foundation for many future studies of global land use and climate change policy.

A New Global Database on Agricultural Land Use

The newly available MRF dataset comprises harvested area and yield for 175 individual crops circa the year 2000 at 5 minute by 5 minute spatial resolution in latitude by longitude (or approximately 10 km by 10 km). Note that areas harvested multiple times in a single year are counted more than once. Yields are in metric tons per harvested hectare, and equal the annual total production in given geographic unit, divided by the total harvested area in that same unit.

MRF note that data availability varies for different crops within each country, with most countries having sub-national statistics for some crops but national statistics for others. Sub-national data included 2,299 political units, one level below the national political level, from 150 countries, and 19,751 units two levels below the national level for 73 countries.

While MRF draw heavily on Agro-MAPS, there were areas where the data from that source were missing or insufficiently detailed. To ensure county level data for the largest countries (Brazil, Argentina, Mexico, Canada, India, the United States, and China), MRF collected additional data from national census agencies and agricultural surveys. When sub-national statistics were unavailable, they relied on national figures from the Food and Agriculture

Organization’s Statistical Databases (FAO, 2006a). In addition, MRF collected independent national level data for four countries that were absent from FAOSTAT—Afghanistan, Iraq, Somalia, and Taiwan.

For purposes of climate change policy analysis in a CGE environment, a key feature of the MRF dataset is the presence of a variety of screens and adjustments that ensure that the resulting, survey-based estimates are: (a) physically feasible, (b) representative of normal growing conditions in the region, and (c) match the national control totals that are widely accepted and used elsewhere in the construction of the GTAP database used in most of the studies reported in Part III of this volume. MRF note that any synthesis of statistical surveys carries with it an inherent risk of misconstruing the definitions of diverse datasets. This is especially true of the production data used to determine yields, which often assume different units among countries that do not also disclose the exact units of measurement. To mitigate against this possibility MRF scale the national totals to match FAOSTAT.

MRF also employ a variety of screens in order to correct for the kinds of errors that frequently arise in agricultural censuses and surveys from uneven data collection, misreporting, or incorrect tabulation. In some cases, this ruled out sub-national sources. In others, this involved adjustment of the data. Consider, for example, the problem of mapping harvested area. Some crops are harvested multiple times per year, which means that the harvested area exceeds the physical area of the cropland that they are grown on. This multiple-cropping potential is constrained by the length of the growing season. Climate conditions and irrigation determine the length of the growing season, which may permit as many as three harvests per year (Economic Research Service 1971). This upper limit on multiple-cropping therefore provided a useful way to check the datasets and correct them if necessary. MRF performed this check by comparing the total harvested area with the total cropland in each grid cell. They began by calculating the ratio of harvested area to total cropland in each grid cell. They then compared this ‘harvest-ratio’ with the multiple-cropping potential in each grid cell, which was estimated differently for rainfed and irrigated regions. In a minority of grid cells, the harvest-ratio exceeded the multiple cropping potential. In order to make the total harvested area in these cells be reasonable given their total cropland, MRF scaled the area of each crop so that the sum of the new crop areas equaled the multiple cropping potential.

For purposes of CGE analysis, the theme of Part III of this volume, we want the land use dataset to be representative of normal growing conditions in a given Agro-Ecological Zone (AEZ). Of course yields, in particular, vary greatly from year to year. Therefore, it is very attractive that MRF have averaged data from the years available between 1997 and 2003 to get a single representative value, circa the year 2000. (In some cases, they had to resort to earlier years for this average.)

Figures 2 and 3 provide an illustration, in the case of wheat, of the harvested area and yield maps from the MRF dataset. Note from Figure 2 (harvested area) that the fraction of the area covered by wheat is highest in South Asia and East Asia, where multiple cropping is possible. Figure 3 reports yield, with the color gradient indicating tonnes/hectare in each grid cell. These yields range from very low (blue) in the mountainous areas of South America, the Great Plains of North America, and much of Central Asia, to very high (red) in Northern Europe, where price supports and scarce land have combined to generate very high yields. Similar data are available from MRF for all 175 FAO crops.

Mapping to the General Equilibrium Framework

For purposes of the work reported in this volume, we would ideally like to exploit the MRF database at its most disaggregated level, that is, 175 crops at the 5 minute x 5 minute level of resolution. However, the essence of general equilibrium analysis, and the core idea behind the work presented in this volume, involves accounting for interactions among different sectors of the economy, and among all regions of the world, and this places some constraints on the degree of disaggregation that can be reasonably obtained. Thus, the global GTAP database upon which most of the studies in this volume are based aggregates all crop production into the 8 broad sectors shown in Table 1. Therefore, the first thing we do is to aggregate the 175 FAO crops in MRF into these 8 sectors, using the mapping shown in Table 1.

The second type of aggregation that is required is across grid cells. However, this is not done on a spatial basis, but rather on the basis of each grid cell's production potential. Just as CGE models often aggregate the labor force into two categories: skilled and unskilled labor, so too must we aggregate land endowments to a more manageable level of detail. Here, we follow Fischer et al., as well as Darwin et al., in aggregating land by Agro-Ecological Zones (AEZs) where the latter are defined by Length of Growing Period (LGP) as well as climatic zone (Table 2).

SAGE derived 6 global LGPs by aggregating the IIASA/FAO GAEZ data into 6 categories of approximately 60 days per LGP: (1) LGP1: 0-59 days, (2) LGP2: 60-119 days, (3) LGP3: 120-179 days, (4) LGP4: 180-239 days, (5) LGP5: 240-299 days, and (6) LGP6: more than 300 days. These 6 LGPs roughly divide the world along humidity gradients, in a manner that is generally consistent with previous studies in global agro-ecological zoning (Alexandratos, 1995). They are calculated as the number of days with sufficient temperature and precipitation/soil moisture for growing crops. These six LGPs are plotted by 0.5 degree grid cell for the world in Figure 4. The colors range from white (shortest LGP) to red (longest LGP). The red tends to be concentrated in the tropics, but not exclusively. The white zones are found in the arctic, the deserts and in the mountain regions.

In addition to the LGP break-down, the world is subdivided into three climatic zones—tropical, temperate, and boreal—using criteria based on absolute minimum temperature and Growing Degree Days, as described in Ramankutty and Foley (1999). Table 2 details definition of global agro-ecological zones used in the GTAP land use database, with the first six AEZs corresponding to tropical climate, the second six to temperate and the last six to boreal. Within each climate grouping, the AEZs progress from short to long LGPs. In addition to reducing the number of separate land endowments in the CGE model, this AEZ approach can also be used to simulate shifts the impacts of changing climate as in Darwin et al. (1995). Furthermore, one could potentially define a suite of feasible land uses within each AEZ, which, although infeasible under current conditions, could become feasible under future conditions.

A global map of 18 the AEZs has been developed by overlaying the 6 categories of LGPs with the 3 climatic zones. Figure 5 shows this 18-AEZ global map by 0.5 degree grid cell. The red shades in the map denote tropical AEZs, with the more intense shades denoting longer growing periods. The green shading denotes temperate AEZs, whereby the darker greens also communicate a longer LGPs. Finally, the boreal climate is portrayed by blue shading.

By way of illustration, Table 3 shows the GTAP sector cropland distribution for China, by AEZ. From this, we can see that most of the crops in China are grown in the temperate area (AEZs 7 to 12). However, the dominance of any given AEZ depends on the crop sector. For example, paddy rice is overwhelmingly grown in the longest temperate LGP (AEZ 12), whereas harvested wheat lands are spread much more evenly across AEZs, with the shorter LGPs playing a much larger role (largest areas are in AEZs 9 and 11). Similarly, coarse grains area is dominated by AEZs 8 and 9. Fruit and vegetable harvested area is rather uniformly spread over AEZs 7 – 11, with a jump in the longest growing period AEZ (12).

Table 4 reports the distribution of production (value terms) by AEZ in China for the 8 crop categories. These figures (in $US millions) are obtained by multiplying harvested area by yield, and then that product by price, at the 175 FAO crop level, thereafter summing over the FAO crops to arrive at the 8 GTAP crop sectors (recall Table 1). Now we can directly compare the economic value of crop production on the different AEZs (refer to the total column). From this, we see that AEZ12 is by far the most productive one in China, followed by AEZ11, 9, 8, 10, 6 and finally 7. The economic values of crop production in the tropical and boreal zones are negligible.

Summary

The recent availability of sub-national data on crop production has permitted us to obtain more direct estimates of harvested area and yield, by crop, at the 5 minute by 5 minute grid cell level over the globe. This is important for the analysis of global change, as the ability to assess which crops compete with one another in a given region can determine the impact of many emerging issues, including attempts to mitigate non-CO_2 greenhouse gases associated with crop production, as well as the impact of expanding biofuel production on other activities in agriculture. As economic modeling of global land use evolves to take better advantage of these newly available data, the demand for further refinements will emerge. This interface between global ecological database and economic modeling provides an exciting frontier for future research.

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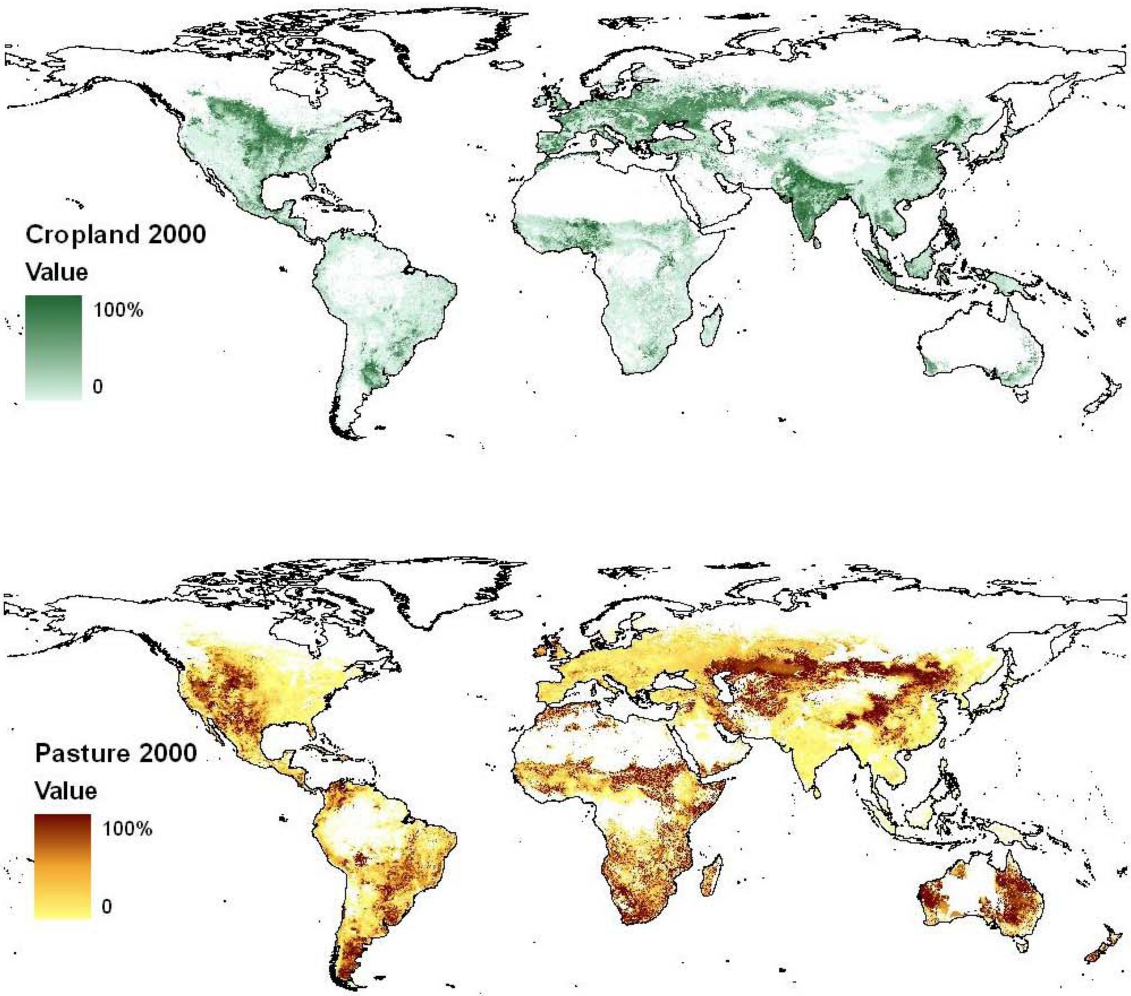

Figure 1. The global distribution of crop and grazing lands *ca*. 2000 from REMF

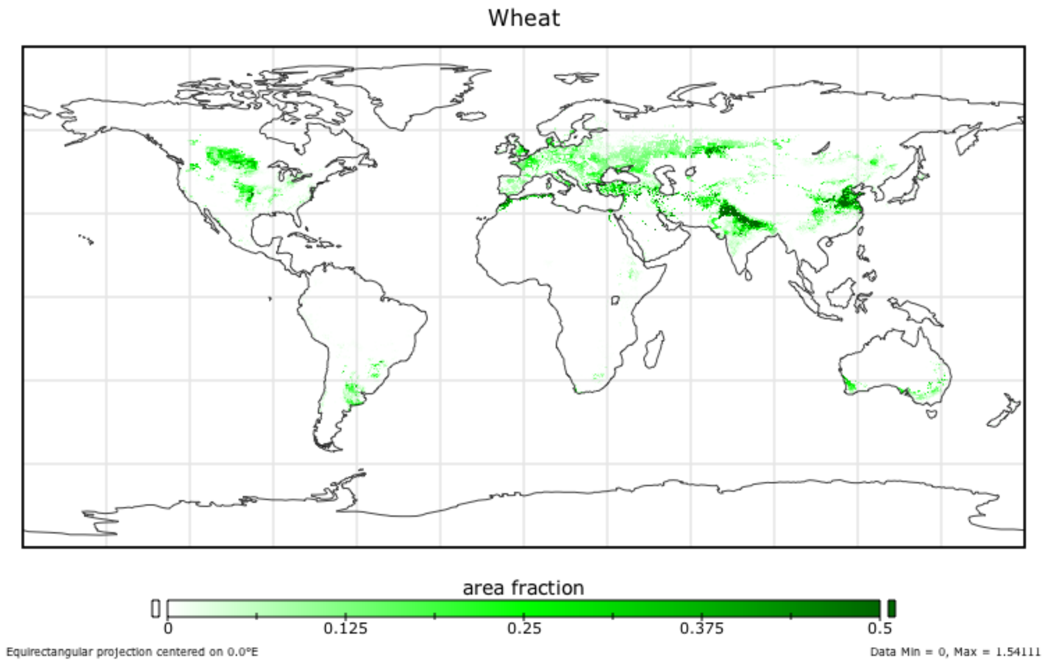

Figure 2. Wheat harvested area expressed as a fraction of each grid cell (MRF dataset)

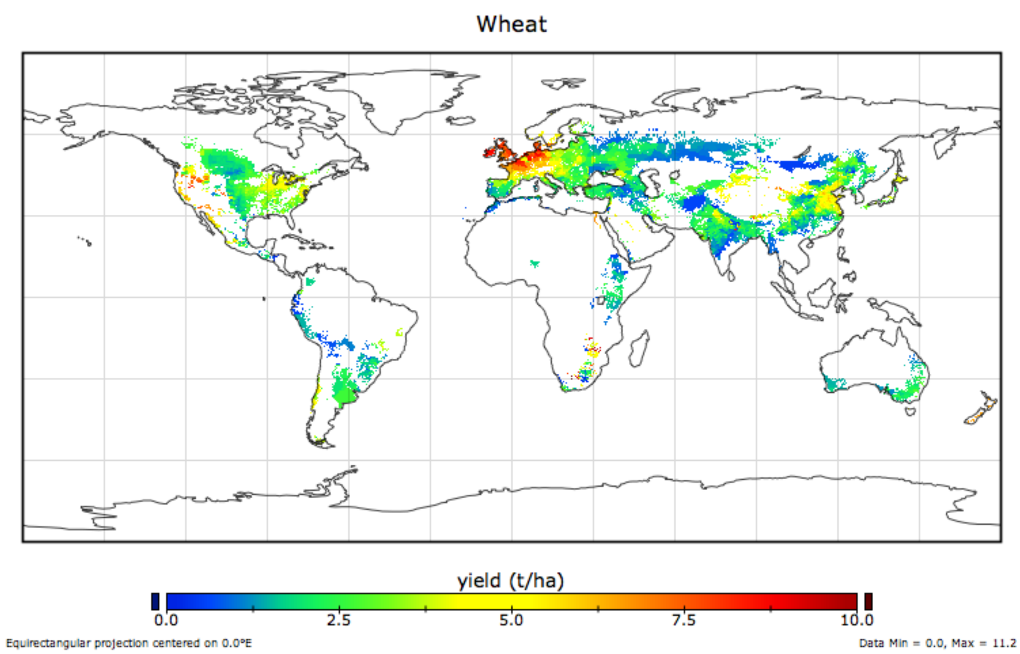

Figure 3. Wheat yields in tonnes/ha. (MRF dataset)

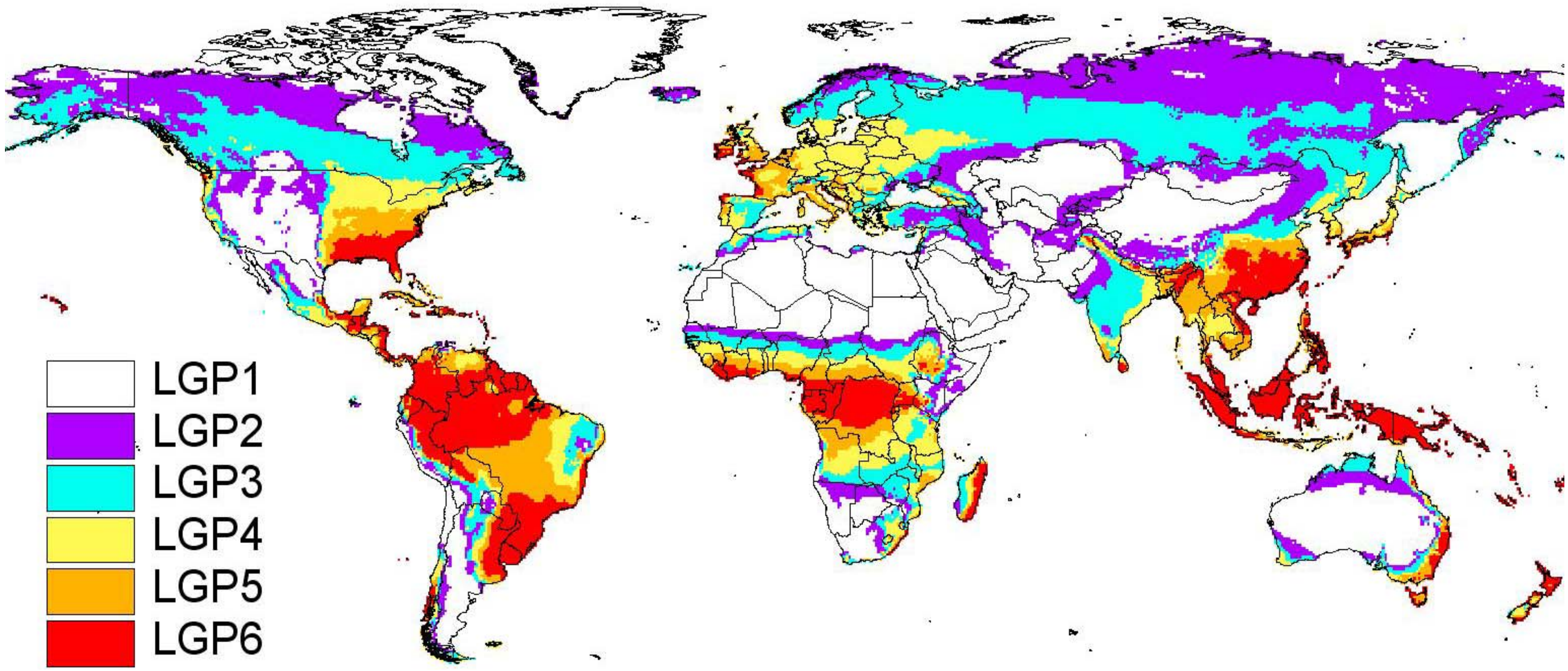

Figure 4. A global map of length of growing periods (LGP)

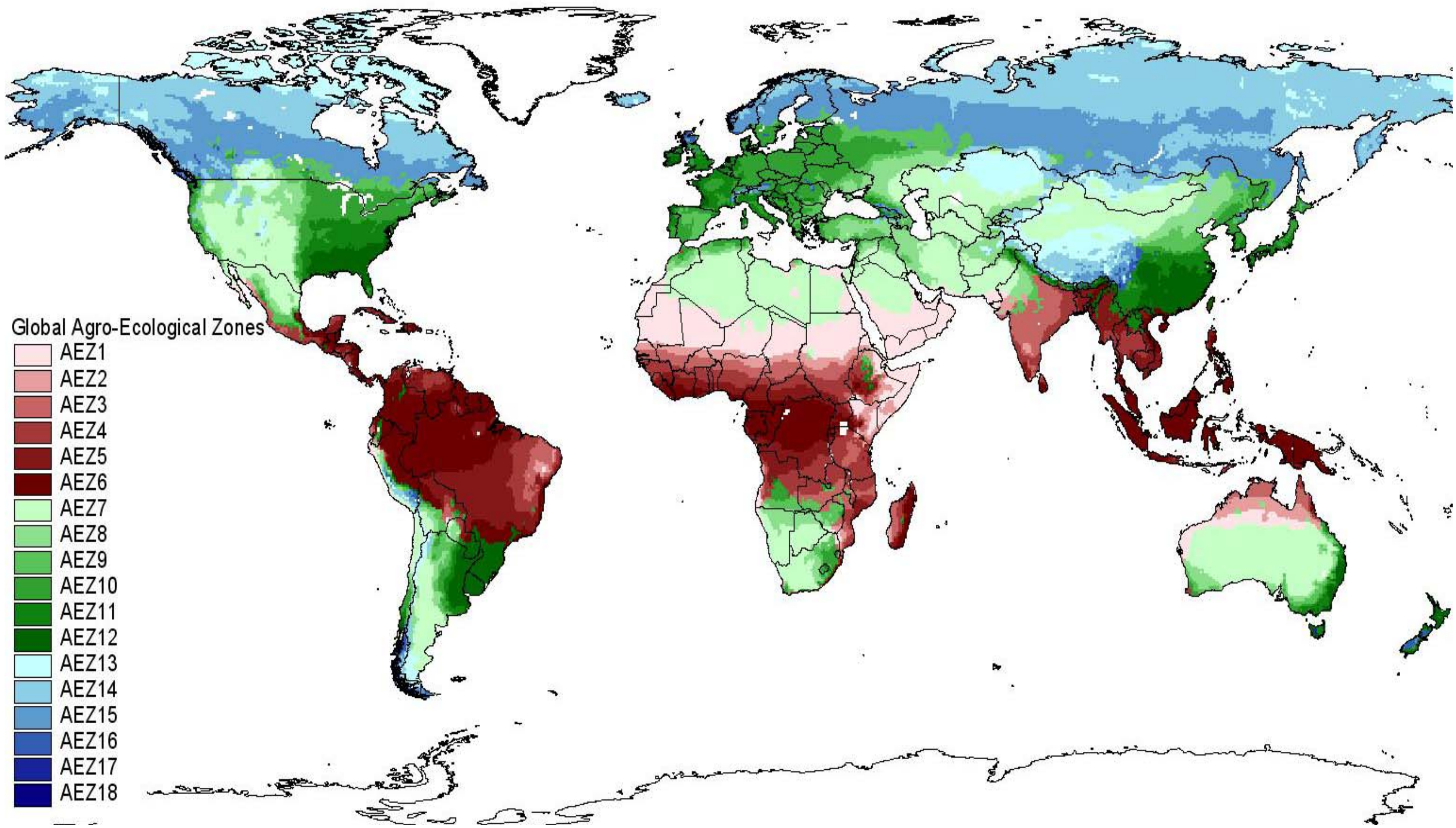

Figure 5. The SAGE global map of the 18 AEZs

Table 1. Mapping of crops between MRF and GTAP data

FAO No.	FAO Code	GTAP No.	GTAP code	Description
1	Barley	3	Gro	Cereals grain n.e.c.
2	Buckwheat	3	Gro	Cereals grain n.e.c.
3	Canary Seed	3	Gro	Cereals grain n.e.c.
4	Cereals, Other	3	gro	Cereals grain n.e.c.
5	Fonio	3	gro	Cereals grain n.e.c.
6	Maize	3	gro	Cereals grain n.e.c.
7	Millet	3	gro	Cereals grain n.e.c.
8	Mixed Grain	3	gro	Cereals grain n.e.c.
9	Oats	3	gro	Cereals grain n.e.c.
10	Pop Corn	3	gro	Cereals grain n.e.c.
11	Quinoa	3	gro	Cereals grain n.e.c.
12	Rice, Paddy	1	pdr	Paddy rice
13	Rye	3	gro	Cereals grain n.e.c.
14	Sorghum	3	gro	Cereals grain n.e.c.
15	Triticale	3	gro	Cereals grain n.e.c.
16	Wheat	2	wht	Wheat
17	Abaca (Manila Hemp)	7	pfb	Plant-based fibres
18	Agave Fibres, Other	7	pfb	Plant-based fibres
19	Coir	7	pfb	Plant-based fibres
20	Fibre Crops, Other	7	pfb	Plant-based fibres
21	Flax Fibre and Tow	7	pfb	Plant-based fibres
22	Hemp Fibre and Tow	7	pfb	Plant-based fibres
23	Jute	7	pfb	Plant-based fibres
24	Jute-Like Fibres	7	pfb	Plant-based fibres
25	Kapok Fibre	7	pfb	Plant-based fibres
26	Kapokseed in Shell	7	pfb	Plant-based fibres
27	Ramie	7	pfb	Plant-based fibres
28	Seed Cotton	7	pfb	Plant-based fibres
29	Sisal	7	pfb	Plant-based fibres
30	Alfalfa for Forage+Silag	8	ocr	Crops n.e.c.
31	Beets for Fodder	8	ocr	Crops n.e.c.
32	Cabbage for Fodder	8	ocr	Crops n.e.c.
33	Carrots for Fodder	8	ocr	Crops n.e.c.
34	Clover for Forage+Silage	8	ocr	Crops n.e.c.
35	Forage Products, Other	8	ocr	Crops n.e.c.
36	GrassesOther,Forage+Silage	8	ocr	Crops n.e.c.
37	Green Oilseeds fr Fodder	8	ocr	Crops n.e.c.
38	Leguminous Other,For+Silage	8	ocr	Crops n.e.c.
39	Maize for Forage+Silage	8	ocr	Crops n.e.c.
40	Mixed Grasses&Legumes	8	ocr	Crops n.e.c.
41	Rye Grass,Forage+Silage	8	ocr	Crops n.e.c.
42	Sorghum for Forage+Silag	8	ocr	Crops n.e.c.
43	Swedes for Fodder	8	ocr	Crops n.e.c.
44	Turnips for Fodder	8	ocr	Crops n.e.c.

45	Vegetables+Roots,Fodder	8	ocr	Crops n.e.c.
46	Apples	4	v_f	Vegetables, fruit, nuts
47	Apricots	4	v_f	Vegetables, fruit, nuts
48	Avocados	4	v_f	Vegetables, fruit, nuts
49	Bananas	4	v_f	Vegetables, fruit, nuts
50	Berries, Other	4	v_f	Vegetables, fruit, nuts
51	Blueberries	4	v_f	Vegetables, fruit, nuts
52	Carobs	4	v_f	Vegetables, fruit, nuts
53	Cashewapple	4	v_f	Vegetables, fruit, nuts
54	Cherries	4	v_f	Vegetables, fruit, nuts
55	Citrus Fruit, Other	4	v_f	Vegetables, fruit, nuts
56	Cranberries	4	v_f	Vegetables, fruit, nuts
57	Currants	4	v_f	Vegetables, fruit, nuts
58	Dates	4	v_f	Vegetables, fruit, nuts
59	Figs	4	v_f	Vegetables, fruit, nuts
60	Fruit Fresh, Other	4	v_f	Vegetables, fruit, nuts
61	Fruit Tropical Fresh, Other	4	v_f	Vegetables, fruit, nuts
62	Gooseberries	4	v_f	Vegetables, fruit, nuts
63	Grapefruit and Pomelos	4	v_f	Vegetables, fruit, nuts
64	Grapes	4	v_f	Vegetables, fruit, nuts
65	Kiwi Fruit	4	v_f	Vegetables, fruit, nuts
66	Lemons and Limes	4	v_f	Vegetables, fruit, nuts
67	Mangoes	4	v_f	Vegetables, fruit, nuts
68	Oranges	4	v_f	Vegetables, fruit, nuts
69	Papayas	4	v_f	Vegetables, fruit, nuts
70	Peaches and Nectarines	4	v_f	Vegetables, fruit, nuts
71	Pears	4	v_f	Vegetables, fruit, nuts
72	Persimmons	4	v_f	Vegetables, fruit, nuts
73	Pineapples	4	v_f	Vegetables, fruit, nuts
74	Plantains	4	v_f	Vegetables, fruit, nuts
75	Plums	4	v_f	Vegetables, fruit, nuts
76	Quinces	4	v_f	Vegetables, fruit, nuts
77	Raspberries	4	v_f	Vegetables, fruit, nuts
78	Sour Cherries	4	v_f	Vegetables, fruit, nuts
79	Stone Fruit, Other	4	v_f	Vegetables, fruit, nuts
80	Strawberries	4	v_f	Vegetables, fruit, nuts
81	Tang.Mand.Clement.Satsma	4	v_f	Vegetables, fruit, nuts
82	Castor Beans	5	osd	Oil seeds
83	Coconuts	5	osd	Oil seeds
84	Groundnuts in Shell	5	osd	Oil seeds
85	Hempseed	5	osd	Oil seeds
86	Karite Nuts (Sheanuts)	5	osd	Oil seeds
87	Linseed	5	osd	Oil seeds
88	Melonseed	5	osd	Oil seeds
89	Mustard Seed	5	osd	Oil seeds
90	Oil Palm Fruit	5	osd	Oil seeds
91	Oilseeds, Other	5	osd	Oil seeds
92	Olives	5	osd	Oil seeds

93	Poppy Seed	5	osd	Oil seeds
94	Rapeseed	5	osd	Oil seeds
95	Safflower Seed	5	osd	Oil seeds
96	Sesame Seed	5	osd	Oil seeds
97	Soybeans	5	osd	Oil seeds
98	Sunflower Seed	5	osd	Oil seeds
99	Tung Nuts	5	osd	Oil seeds
100	Anise and Badian and Fennel	8	ocr	Crops n.e.c.
101	Areca Nuts (Betel)	4	v_f	Vegetables, fruit, nuts
102	Chicory Roots	4	v_f	Vegetables, fruit, nuts
103	Cinnamon (Canella)	8	ocr	Crops n.e.c.
104	Cloves	8	ocr	Crops n.e.c.
105	Cocoa Beans	8	ocr	Crops n.e.c.
106	Coffee, Green	8	ocr	Crops n.e.c.
107	Ginger	8	ocr	Crops n.e.c.
108	Hops	8	ocr	Crops n.e.c.
109	Kolanuts	4	v_f	Vegetables, fruit, nuts
110	Mate	8	ocr	Crops n.e.c.
111	Natural Gums		frs	
112	Natural Rubber		frs	
113	Nutmeg and Mace and Cardamoms	8	ocr	Crops n.e.c.
114	Pepper	8	ocr	Crops n.e.c.
115	Peppermint	8	ocr	Crops n.e.c.
116	Pimento	8	ocr	Crops n.e.c.
117	Pyrethrum, Dried Flowers	8	ocr	Crops n.e.c.
118	Spices, Other	8	ocr	Crops n.e.c.
119	Tea	8	ocr	Crops n.e.c.
120	Tobacco Leaves	8	ocr	Crops n.e.c.
121	Vanilla	8	ocr	Crops n.e.c.
122	Bambara Beans	4	v_f	Vegetables, fruit, nuts
123	Beans, Dry	4	v_f	Vegetables, fruit, nuts
124	Broad Beans, Dry	4	v_f	Vegetables, fruit, nuts
125	Chick-Peas	4	v_f	Vegetables, fruit, nuts
126	Cow Peas, Dry	4	v_f	Vegetables, fruit, nuts
127	Lentils	4	v_f	Vegetables, fruit, nuts
128	Lupins	8	ocr	Crops n.e.c.
129	Peas, Dry	4	v_f	Vegetables, fruit, nuts
130	Pigeon Peas	4	v_f	Vegetables, fruit, nuts
131	Pulses, Other	4	v_f	Vegetables, fruit, nuts
132	Vetches	8	ocr	Crops n.e.c.
133	Cassava	4	v_f	Vegetables, fruit, nuts
134	Potatoes	4	v_f	Vegetables, fruit, nuts
135	Roots and Tubers, Other	8	ocr	Crops n.e.c.
136	Sweet Potatoes	4	v_f	Vegetables, fruit, nuts
137	Taro (Coco Yam)	4	v_f	Vegetables, fruit, nuts
138	Yams	4	v_f	Vegetables, fruit, nuts
139	Yautia (Cocoyam)	4	v_f	Vegetables, fruit, nuts
140	Sugar Beets	6	c_b	Sugar cane, sugar beet

141	Sugar Cane	6	c_b	Sugar cane, sugar beet
142	Sugar Crops, Other	6	c_b	Sugar cane, sugar beet
143	Almonds	4	v_f	Vegetables, fruit, nuts
144	Brazil Nuts	4	v_f	Vegetables, fruit, nuts
145	Cashew Nuts	4	v_f	Vegetables, fruit, nuts
146	Chestnuts	4	v_f	Vegetables, fruit, nuts
147	Hazelnuts (Filberts)	4	v_f	Vegetables, fruit, nuts
148	Nuts, Other	4	v_f	Vegetables, fruit, nuts
149	Pistachios	4	v_f	Vegetables, fruit, nuts
150	Walnuts	4	v_f	Vegetables, fruit, nuts
151	Artichokes	4	v_f	Vegetables, fruit, nuts
152	Asparagus	4	v_f	Vegetables, fruit, nuts
153	Beans, Green	4	v_f	Vegetables, fruit, nuts
154	Broad Beans, Green	4	v_f	Vegetables, fruit, nuts
155	Cabbages	4	v_f	Vegetables, fruit, nuts
156	Cantaloupes&oth Melons	4	v_f	Vegetables, fruit, nuts
157	Carrots	4	v_f	Vegetables, fruit, nuts
158	Cauliflower	4	v_f	Vegetables, fruit, nuts
159	Chillies&Peppers, Green	4	v_f	Vegetables, fruit, nuts
160	Cucumbers and Gherkins	4	v_f	Vegetables, fruit, nuts
161	Eggplants	4	v_f	Vegetables, fruit, nuts
162	Garlic	4	v_f	Vegetables, fruit, nuts
163	Green Corn (Maize)	4	v_f	Vegetables, fruit, nuts
164	Lettuce	4	v_f	Vegetables, fruit, nuts
165	Mushrooms	8	ocr	Crops n.e.c.
166	Okra	4	v_f	Vegetables, fruit, nuts
167	Onions, Dry	4	v_f	Vegetables, fruit, nuts
168	Onions+Shallots, Green	4	v_f	Vegetables, fruit, nuts
169	Peas, Green	4	v_f	Vegetables, fruit, nuts
170	Pumpkins, Squash, Gourds	4	v_f	Vegetables, fruit, nuts
171	Spinach	4	v_f	Vegetables, fruit, nuts
172	String Beans	4	v_f	Vegetables, fruit, nuts
173	Tomatoes	4	v_f	Vegetables, fruit, nuts
174	Vegetables Fresh, Other	4	v_f	Vegetables, fruit, nuts
175	Watermelons	4	v_f	Vegetables, fruit, nuts

Table 2. Definition of global agro-ecological zones used in GTAP

LGP in days	Moisture regime	Climate zone	GTAP class
0-59	Arid	Tropical	AEZ1
		Temperate	AEZ7
		Boreal	AEZ13
60-119	Dry semi-arid	Tropical	AEZ2
		Temperate	AEZ8
		Boreal	AEZ14
120-179	Moist semi-arid	Tropical	AEZ3
		Temperate	AEZ9
		Boreal	AEZ15
180-239	Sub-humid	Tropical	AEZ4
		Temperate	AEZ10
		Boreal	AEZ16
240-299	Humid;	Tropical	AEZ5
		Temperate	AEZ11
		Boreal	AEZ17
>300 days	Humid; year-round growing season	Tropical	AEZ6
		Temperate	AEZ12
		Boreal	AEZ18

Table 3. Cropland use (harvested area): China, ca. 2000 (unit: 1000 hectare)

	Paddy rice	Wheat	Cereal grains	Vegetables/ fruits/nuts	Oil seeds	Sugar cane/beet	Plant-based fibres	Crops N.E.C.
AEZ1	0	0	0	0	0	0	0	0
AEZ2	0	0	0	0	0	0	0	0
AEZ3	0	0	0	0	0	0	0	0
AEZ4	27.525	0	3.713	26.511	2.696	2.989	0	11.03
AEZ5	76.743	1.024	17.143	60.286	13.691	8.073	1.072	22.721
AEZ6	2205.09	31.539	163.257	2264.922	512.905	559.109	10.563	185.859
AEZ7	84.102	1124.754	702.075	415.938	349.152	71.61	474.478	177.316
AEZ8	565.323	3190.747	7982.679	4925.148	3290.609	153.729	193.873	348.159
AEZ9	1014.393	6853.895	9081.908	6154.133	3331.428	69.736	1171.693	366.786
AEZ10	1021.792	3969.54	3676.688	3705.252	2168.829	42.227	375.359	399.12
AEZ11	5740.133	6942.601	3966.744	6137.338	4763.77	172.703	1214.219	911.445
AEZ12	21412.28	3939.014	3800.956	13747.41	8206.075	640.133	1097.171	1899.705
AEZ13	5.237	228.82	109.756	68.627	130.517	14.933	48.894	54.852
AEZ14	2.227	171.973	43.695	54.591	96.519	1.978	0.38	14.402
AEZ15	72.084	191.225	198.217	106.832	239.746	19.442	0.375	24.073
AEZ16	24.719	95.019	84.271	74.848	61.979	0.553	0.127	19.767
AEZ17	1.253	5.838	8.249	3.073	3.22	0	0	0.561
AEZ18	0	0	0	0	0	0	0	0
Total	32252.9	26745.99	29839.35	37744.91	23171.14	1757.215	4588.204	4435.796

Table 4. Estimated crop production, by GTAP sector and AEZ: China, 2001 ($US million)

Unit: million USD	1 pdr	2 wht	3 gro	4 v_f	5 osd	6 c_b	7 pfb	8 ocr	Total
1 AEZ1	0	0	0	0	0	0	0	0	0
2 AEZ2	0	0	0	0	0	0	0	0	0
3 AEZ3	0	0	0	0	0	0	0	0	0
4 AEZ4	3.6	0	0.3	34.6	0.5	0.5	0	4.1	43.6
5 AEZ5	10	0	0.8	81.1	1.6	1.3	0.1	8.1	103
6 AEZ6	245.2	1.2	4.6	2287.3	53.4	90	0.2	51.3	2733.2
7 AEZ7	14.6	71	43.4	356.9	19.3	7.9	129.3	48.7	691.1
8 AEZ8	93.3	187.3	423.8	3223.6	232.7	9.4	53.1	60	4283.2
9 AEZ9	179.3	449	539.2	5011.7	360	3.8	231.3	37.7	6812
10 AEZ10	166.2	231.9	201.3	2920.4	282.2	2.9	86.1	47.6	3938.6
11 AEZ11	938.2	397.7	159.2	4696.7	396.1	24.1	269	110.5	6991.5
12 AEZ12	2983	174	135.8	12115.1	541.5	94.3	275.9	407.3	16726.9
13 AEZ13	0.7	14	7	66.3	7.1	1.9	13.8	15	125.8
14 AEZ14	0.3	8.4	2	26	5.8	0.2	0.1	4.2	47
15 AEZ15	10.6	9.5	13.9	60.3	19.1	1.1	0	3	117.5
16 AEZ16	2.7	3.7	2.8	28.5	4.2	0.1	0	5.4	47.4
17 AEZ17	0.1	0.2	0.2	1	0.2	0	0	0.2	1.9
18 AEZ18	0	0	0	0	0	0	0	0	0
19 UnSkLab	6977.7	2323.7	2303.5	46402.6	2888.3	356.5	1589.6	1205.6	64047.5
20 SkLab	56.3	18.7	18.6	374.2	23.3	2.9	12.8	9.7	516.5
21 Capital	1430.6	476.4	472.3	9513.9	592.2	73.1	325.9	247.2	13131.6
22 NatRes	0	0	0	0	0	0	0	0	0
Total	13112.6	4366.8	4328.8	87200.3	5427.8	669.9	2987.3	2265.7	