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Diversity of Land Use and Land Cover

Richly structured landscapes harbor more species, such as those in need of several habitat types side by side because they require different conditions to be met for foraging, raising their young, and resting. Hence, most living beings will thrive in a habitat mosaic composed of forests, open grassland, waterbodies, etc. However, species depending on habitats characterized by large-scale uniformity suffer when exposed to distinctly small-scale land division. Small-scaleness also has an adverse effect on biodiversity when it is the result of habitats being cut up.

For this reason, E5 can only be conclusively assessed in conjunction with other BDM indicators (primarily "Species Diversity in Landscapes (Z7)" and "Population Size of Common Species (Z8)"). Nationwide, diversity of land use and land cover has hardly changed at all in the past 15 years. But there are regional differences: Between 1985 and 2009, diversity of land use and land cover has been increasing in the Jura, on the Central Plateau and in the Northern Alps, while decreasing in the Central Alps and the Southern Alps. Furthermore, a special analysis reveals the impact of land use and land cover diversity on species diversity. Whenever the E5 indicator changes either due to a rise or a decline in the diversity of land use and land cover, the Z7 indicator "Species Diversity in Landscapes" is likely to change as well.

Status: December 2015

Contents

Development in Switzerland

Nationwide, diversity of land use and land cover has hardly changed at all in the past 15 years.

Table 1 below lists the diversity of land use and land cover in Switzerland as expressed by the mean number of changes in category of neighboring sampling points per square kilometer. For a change to be found present, two directly neighboring Swiss Land Use Statistics sampling points must differ in either land use or land cover categories (see “Surveying methods”). Means of changes shown have been established with a 95% confidence interval. The situations recorded for 1985, 1997 and 2009 refer to the Swiss Land Use Statistics of 1979/85, 1992/97 and 2004/09 respectively.

Tab. 1: Mean number of changes per square kilometer

	Situation in 1985	Situation in 1997	Situation in 2009	Changes 1985–2009
Nationwide	66.8 ± 0.3	66.0 ± 0.3	66.7 ± 0.3	-0.1 ± 0.1

Interpretation example

Between 1985 and 2009, the mean number of changes in land use and land cover categories per square kilometer declined by 0.1 units.

Comments

- Diversity of land use and land cover does not seem to have changed during the observation period as a whole. However, when surveying periods are being viewed individually, diversity declined between 1985 and 1997, only to increase again to almost the same degree between 1997 and 2009.
- Diversity of land use and land cover staying the same does not necessarily mean that the landscape did not change. If, for example, one type of land use is replaced by another that still differs from the one captured at the neighboring sampling point, the indicator value stays the same. Yet such a change in land use may still have a positive or negative impact on biodiversity (see also “Changes of land use and land cover diversity in time” further on).
- Even though diversity of land use and land cover remained constant nationwide, changes have indeed been registered in individual regions (see below).

Source

Swiss Federal Statistical Office, Swiss Land Use Statistics.

Status

December 2015. Data will be updated again after the fourth Swiss Land Use Statistics survey has been completed. It will be conducted based on aerial photographs taken in the period of 2012 to 2018. Interpretations are scheduled to be finalized by 2020.

Development in the regions

In Switzerland's biogeographical regions, diversity of land use and land cover has been increasing or declining to varying degrees.

Table 2 below lists diversity of land use and land cover by biogeographical region as expressed by the mean number of changes in category of neighboring sampling points per square kilometer. For a change to be found present, two directly neighboring Swiss Land Use Statistics sampling points must differ in either land use or land cover categories (see “Surveying methods”). Means of changes shown have been established with a 95% confidence interval. The situations recorded for 1985, 1997 and 2009 refer to the Swiss Land Use Statistics of 1979/85, 1992/97 and 2004/09 respectively.

Tab. 2: Mean number of changes per square kilometer in the regions

	Situation in 1985	Situation in 1997	Situation in 2009	Changes 1985–2009
Jura	69.5 ± 0.8	68.9 ± 0.8	70.6 ± 0.7	1.1 ± 0.3
Central Plateau	71.4 ± 0.6	70.3 ± 0.5	72.6 ± 0.5	1.3 ± 0.2
Northern Alps	68.3 ± 0.5	68.4 ± 0.5	69.5 ± 0.5	1.2 ± 0.2
Western Central Alps	58.5 ± 1.0	57.6 ± 1.0	56.2 ± 1.0	-2.3 ± 0.3
Eastern Central Alps	60.2 ± 0.8	59.3 ± 0.8	58.0 ± 0.8	-2.2 ± 0.3
Southern Alps	66.7 ± 1.0	64.2 ± 1.0	62.8 ± 1.0	-3.9 ± 0.4

Interpretation example

In 1985, types of land use or land cover per square kilometer in the Northern Alps changed 67.8 to 68.8 times on average. 24 years later, the number of changes had risen to 69.0 to 70.0, increasing the mean diversity of land use and land cover in the Northern Alps by 1.0 to 1.4 changes per square kilometer.

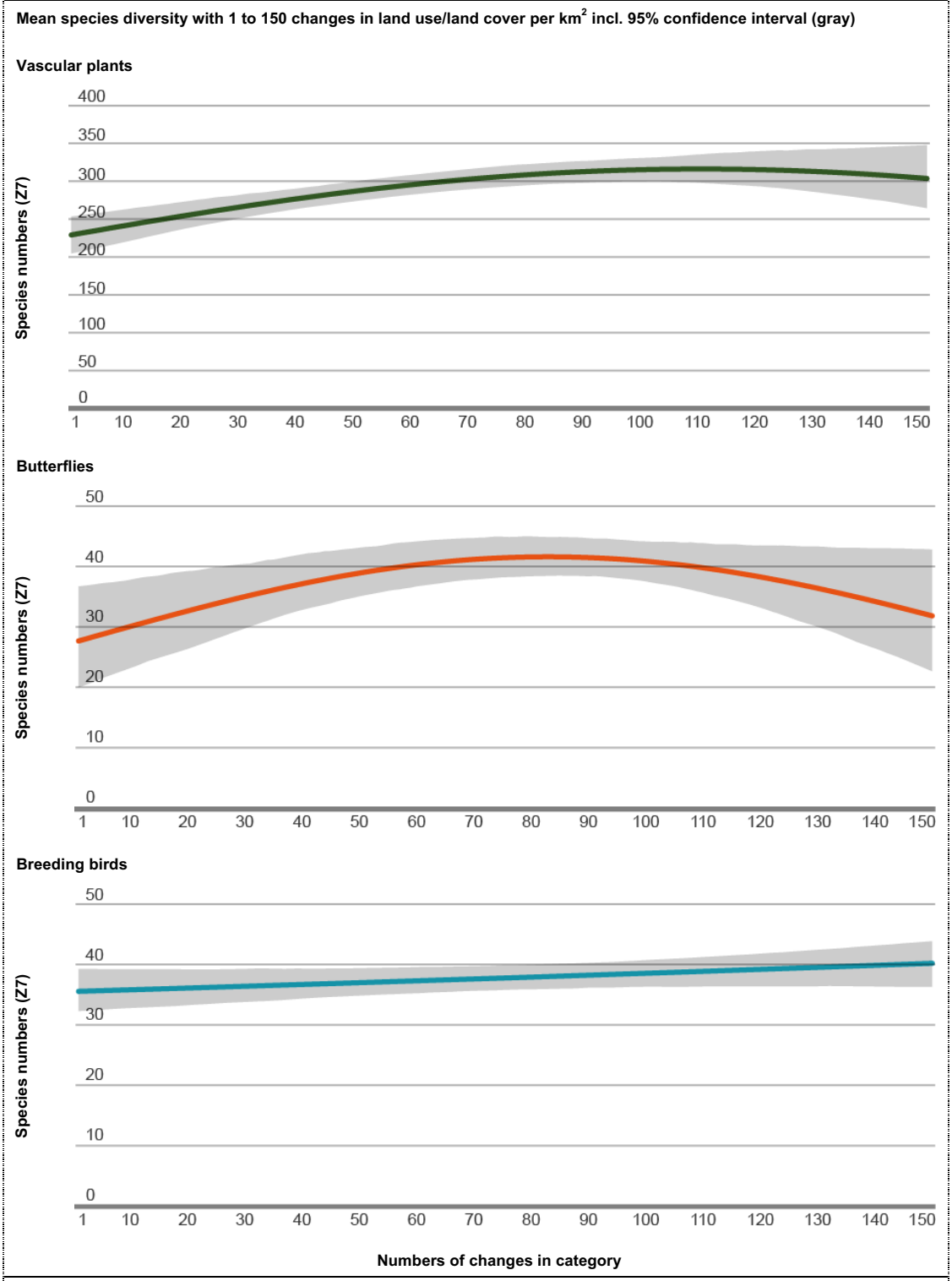
Comments

- Between the first and second surveying periods, diversity of land use and land cover declined in all regions except the Northern Alps, where it stayed constant.
- Between the second and third surveying periods, diversity of land use and land cover reincreased in the Jura, on the Central Plateau and in the Northern Alps, but kept declining in the Central Alps and in the Southern Alps.
- Viewed overall, developments between 1985 and 2009 result in an increase of land use and land cover diversity in the Jura, on the Central Plateau and in the Northern Alps, while diversity drops even more sharply in the Central Alps and the Southern Alps.

Impact of land use/cover diversity on species diversity

A special analysis of BDM data was used to verify whether the number of changes in land use or land cover category is connected with species numbers of vascular plants, butterflies and breeding birds. Moreover, the impact of this indicator on species diversity in landscapes (Z7 indicator) was compared to other factors also influencing species diversity, such as elevation and various climate parameters.

Fig. 1: Connection between land use/cover diversity and species numbers



Comments

- As regards vascular plants, 1-km^2 sampling areas characterized by many changes in land use or land cover harbor more species than areas that underwent only a few changes.

- Maximum species diversity of butterflies is observed in 1-km^2 sampling areas featuring a mean number of changes in land use or land cover.
- For breeding birds, the importance of land use and land cover diversity is relatively low compared to other variables.
- A mosaic of habitats is of vital importance for vascular plants and butterflies, so much so that the number of changes in land use or land cover category is one of the key determinants of species diversity. Yet variables related to species temperature niches—such as mean annual temperature, elevation, or insolation—are very important for these two species groups as well.

Generally speaking, species diversity in landscapes (Z7 indicator) is expected to change along with diversity of land use and land cover (E5 indicator).

Changes of land use/cover diversity in time

When changes in land use/cover increase between some categories while simultaneously declining between others, the E5 indicator stays the same even though diversity of land use and land cover is actually altered. Hence, in order to gain differentiated insights, BDM counts numbers of changes per category of land use/cover, comparing them across surveying periods. In doing so, it obtains important additional information on how the landscape changes both in Switzerland as a whole and its biogeographical regions.

Based on Swiss Land Use Statistics, BDM uses the following aggregated categories (cf. Appendix):

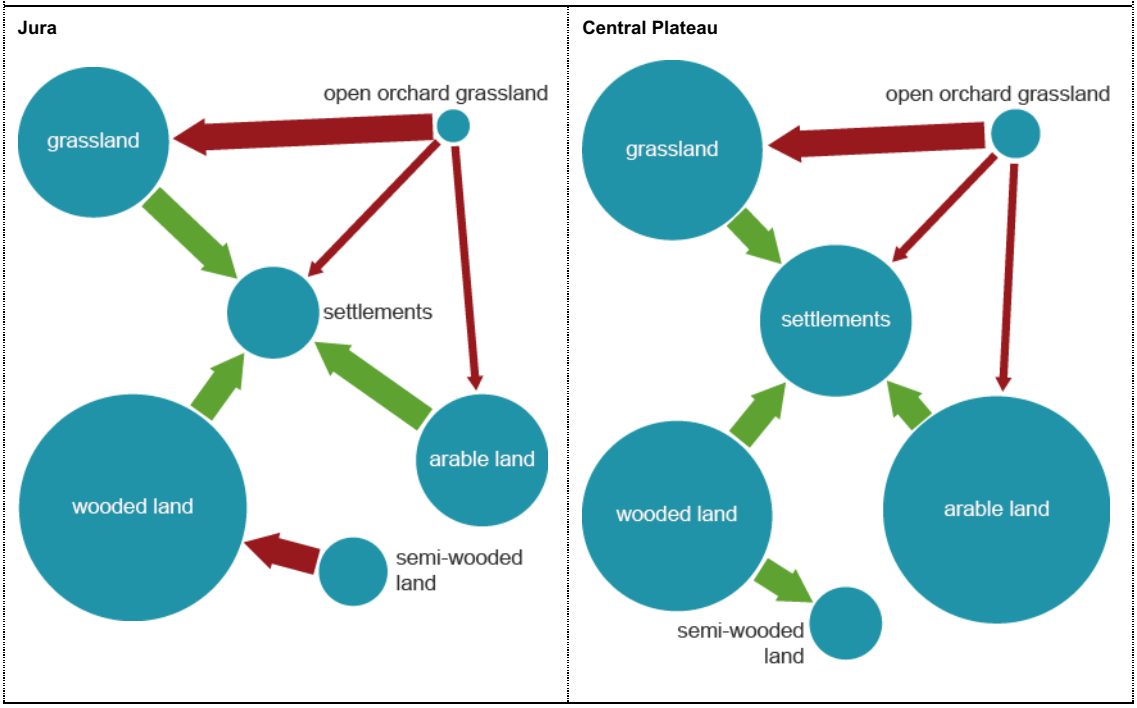
1. Settlements incl. surroundings and vehicular/pedestrian infrastructure
2. Industry, commerce
3. Recreational areas and green spaces
4. Arable land
5. Vineyards
6. Orchards and horticultural land
7. Open orchard grassland
8. Grassland and farm pastures
9. Wooded land
10. Semi-wooded land
11. Coppice, shrub and transition stages
12. Extensive grassland (Alpine pastures)
13. Open spaces with no/little vegetation
14. Glaciers, firn
15. Wetlands
16. Watercourses, flood protection structures
17. Waterbodies

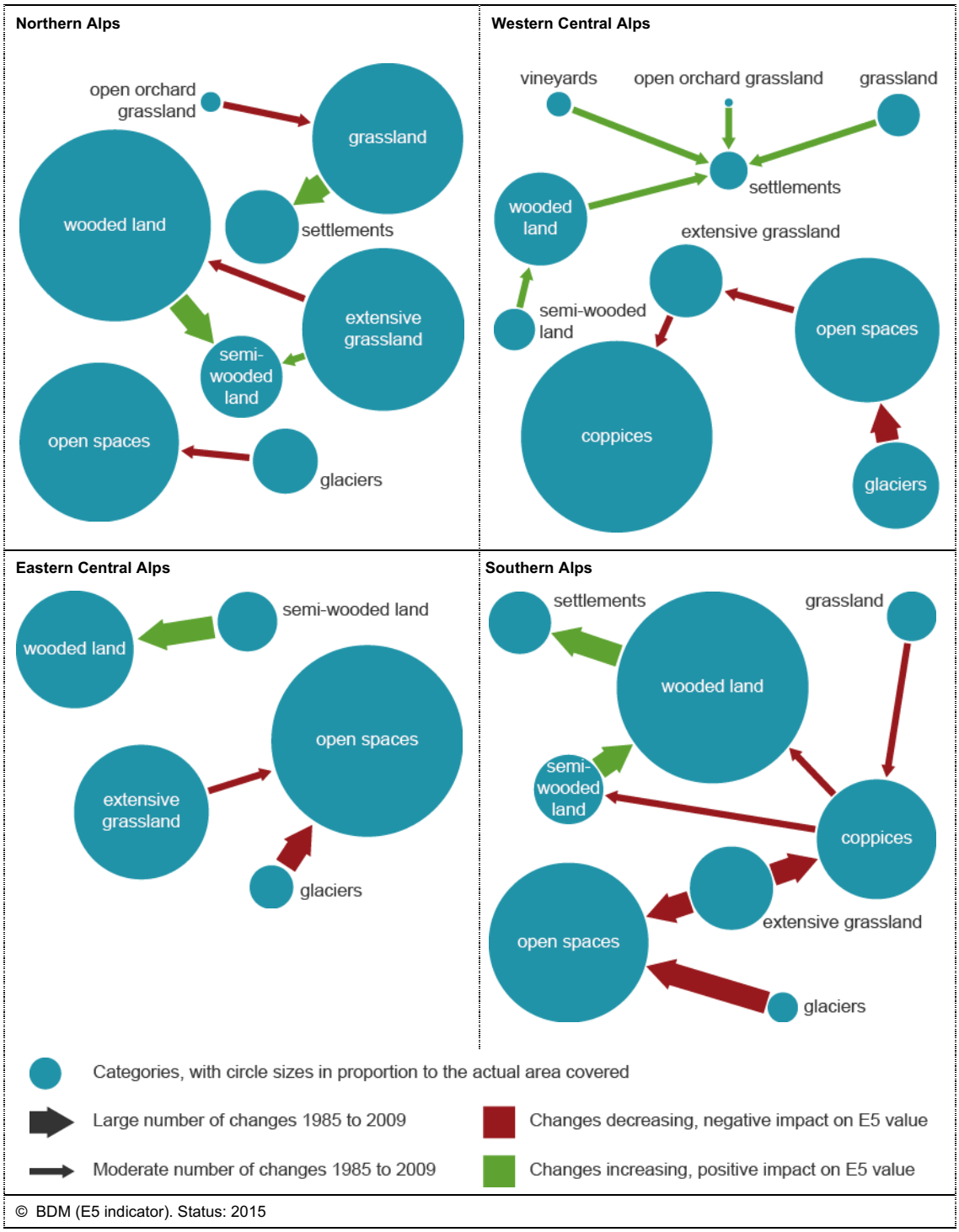
Figure 2 below illustrates some particularly marked changes. Red arrows symbolize fewer changes found between two categories, the reason being that one of the two has been transformed into the other.

Conversely, green arrows imply an increase in changes, which results from different categories emerging out of previously homogeneous areas.

These two contrary developments may cancel each other out if—as is done in computing this indicator's key message—only the number of changes is being considered.

Fig. 2: Variations in category changes between 1985 and 2009





Interpretation example

In the Jura, the number of changes between “open orchard grassland” and “grassland” categories has been declining considerably between 1985 and 2009. This is the result of many sampling points still classified as “open orchard grassland” in 1985 turning into “grassland” in the following 25 years after fruit trees had died or been felled.

Comments on significant changes

- Due to settlement spreading and/or suburban sprawl, diversity of land use and land cover is significantly increasing in **all regions**, but above all in the **Jura** and on the **Central Plateau**.
- Both in the **Jura** and on the **Central Plateau**, the number of changes between “open orchard grassland” and other land use categories has considerably declined as a result of fruit trees being increasingly removed in favor of “grassland and farm pastures”, “arable land” and “settlements” during the past two decades.
- On the **Central Plateau** and in the **Northern Alps**, the number of changes from “wooded land” to “semi-wooded land” land cover categories has been rising rather markedly. This development may be attributed to the increase of semi-wooded land in windfall areas (after violent storms Vivian in 1990 and Lothar in 1999).
- In the **Jura**, the number of changes between “semi-wooded land” and other land cover categories has declined because traditional forest pastures—which are part of the “semi-wooded land” category—were replaced by open pastures.
- The increase in the number of changes from “semi-wooded land” to other land cover categories has been relatively moderate in the **Central Alps,** but distinct in the **Southern Alps**. Formerly open spaces were first encroached by scrub, subsequently turned into semi-wooded land and finally into wooded land.
- The number of changes between “coppice, shrub and transition stages” and other land use categories has been declining **in general**. This finding may be explained by hedges and coppices being removed in favor of grassland in the lowlands, by scrubland turning into wooded land in the mountains (mainly in the **Southern Alps**) or by both developments in the **Jura**.
- As low-yielding remote farmland in the **Alps** and in the **Jura** was abandoned, the number of changes between “alpine pastures” and other land use categories such as “open spaces” and “wooded land” has declined. Abandoned areas are increasingly encroached by scrub, subsequently turning into semi-wooded and finally wooded land.
- The marked decline in the number of changes between “glaciers, firn” and other land cover categories in the **Central Alps** and the **Southern Alps** is the result of glaciers retreating.

Source

Swiss Federal Statistical Office, Swiss Land Use Statistics.

Status

December 2015. Data will be updated again after the fourth Swiss Land Use Statistics survey has been completed. It will be conducted based on aerial photographs taken in the period of 2012 to 2018. Interpretations are scheduled to be finalized by 2020.

Significance for biodiversity

The spatial distribution of habitats within the landscape affects biodiversity. Richly structured landscapes offer more habitats than monotonous environments, which in turn makes them suitable for a larger number of species. Many species depend on landscape diversity because they forage, rest, breed, and raise their young in different habitats. The black grouse, for example, forages in the undergrowth of clear forests, but needs open areas for lekking. For this reason, a mosaic of habitat types is likely to have a favorable effect on biodiversity. However, the composition of this mosaic is of vital importance. Densifying the road

network creates small-area habitats as well, but since it cuts up formerly cohesive habitats first, it is bad for biodiversity. Hence, increasing the diversity of land use and land cover can have either a positive or a negative impact on biodiversity. As a result, the E5 indicator must be assessed in conjunction with other BDM indicators, particularly “Species Diversity in Landscapes (Z7)” and “Population Size of Common Species (Z8)”.

Definition

Variations in the number of changes of neighboring sampling points from one type of land use or land cover to another within one square kilometer, aggregated by biogeographical region and for Switzerland as a whole.

The indicator is based on the categorization used in the Swiss Land Use Statistics of the Swiss Federal Statistical Office.

Surveying methods

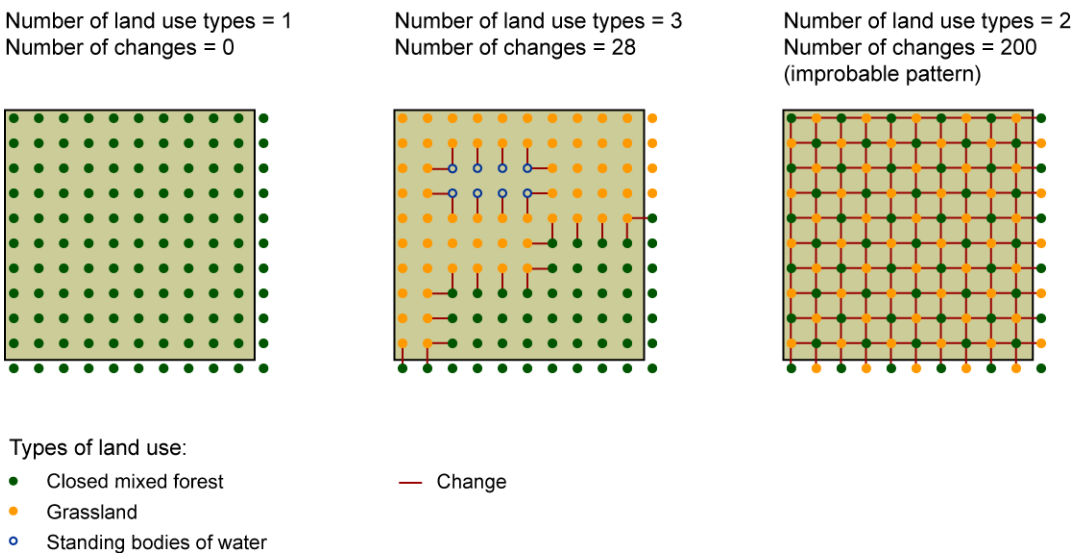
The E5 indicator compares the mean number of changes in land use and land cover category per square kilometer registered between 1979/85, 1992/97 and 2004/2009 in Switzerland’s biogeographical regions and the country as a whole.

Basic data have been extracted from the Swiss Land Use Statistics of 1979/85, 1992/97 and 2004/2009 established by the Swiss Federal Statistical Office using a sampling network characterized by a 100-meter grid spacing on hectometer coordinates. This method results in 100 sampling points per square kilometer or 4.1 million sampling points all over Switzerland. Using stereoscopic air-photo interpretation, each one of these sampling points was assigned to one of the 74 use categories covered by the Swiss Land Use Statistics. BDM condenses these 74 use categories into 17 land use categories (see list below).

Using this new categorization system, it is possible to differentiate land uses and land covers of ecologic significance. Furthermore, BDM data can now be compared to the European CORINE Land Cover system.

BDM land uses at sampling points are compared to land uses at neighboring points both in a horizontal (West-East) and vertical (North-South) direction. Each transition from one type of land use to another is counted as one change, allowing for 0 to 200 changes per square kilometer.

Fig. 3: Simplified sample illustration of different land use patterns per square kilometer



Further information

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Additional sources of information

> Comprehensive information on Swiss Land Use Statistics of 1979/85, 1992/97 and 2004/09 (only in German and French http://www.bfs.admin.ch/bfs/portal/de/index/themen/02/03.html

This information is based on the German-language document 1360_E5_Basisdaten_2015_V1_dt.docx dated Mai 26th, 2016.

Appendix: List of the 17 BDM land use categories:

BDM category	**Swiss Land Use Statistics basic categories**		**BDM E5 code**
	N°	**Description**	
Settlements incl. surroundings and vehicular/pedestrian infrastructure	3	Single-family and double-family houses	**1**
	4	Surroundings of single-family and double-family houses	
	5	Row houses and terraced houses	
	6	Surroundings of row houses and terraced houses	
	7	Apartment blocks	
	8	Surroundings of apartment blocks	
	9	Public buildings	
	10	Surroundings of public buildings	
	11	Agricultural buildings	
	12	Surroundings of agricultural buildings	
	13	Unspecified buildings	
	14	Surroundings of unspecified buildings	
	15	Freeways	
	16	Freeway green features	
	17	Roads, trails	
	18	Road green features	
	19	Parking lots	
	20	Railway station grounds	
	21	Railway green features	
	22	Airports	
	23	Airfields, airport green features	
Industry, commerce	1	Industrial and commercial buildings	**2**
	2	Surroundings of industrial and commercial buildings	
	24	Power plants	
	25	Sewage treatment plants	
	26	Other supply and waste disposal plants	
	27	Dumps	
	28	Mines	
	29	Construction sites	
	30	Derelict land	
Recreational areas and green spaces	31	Public parks	**3**
	32	Sports facilities	
	33	Golf courses	
	34	Campgrounds	
	35	Community gardens	
	36	Cemeteries	
Arable land	41	Arable land	**4**

Vineyards	39	Vineyards	**5**
Orchards and horticultural land	37	Orchards	**6**
	40	Horticultural land	
Open orchard grassland	38	Open orchard grassland	**7**
Grassland and farm pastures	42	Natural meadows	**8**
	43	Farm pastures	
Wooded land	50	Normal forests	**9**
	51	Forest strips	
Semi-wooded land	52	Afforestations	**10**
	53	Thinned or cut-down stands	
	54	Damaged forests	
	55	Semi-wooded land (on agricultural areas)	
	56	Semi-wooded land (on nonproductive areas)	
Coppice, shrub and transition stages	44	Meadows and farm pastures colonized by scrub (for 50-80%)	**11**
	47	Alpine and Jura pastures colonized by scrub (for 50-80%)	
	57	Alpine shrubland	
	64	Alpine brush and shrub vegetation	
	58	Field coppices and hedges	
	59	Tree groups (on agricultural areas)	
	60	Tree groups (on nonproductive areas)	
Extensive grassland (Alpine pastures)	45	Alpine grassland	**12**
	46	Permanently grazed alpine and Jura pastures	
	49	Alpine sheep pastures	
Open spaces with no/little vegetation	48	Rocky alpine and Jura pastures (50-80% rocks)	**13**
	65	Nonproductive grassland and herbaceous vegetation	
	66	Avalanche and rockfall protection structures	
	68	Alpine sports infrastructures	
	69	Rock	
	70	Pebbles, sand	
	71	Areas temporarily changed due to construction activities	
Glaciers, firn	72	Glaciers, firn	**14**
Wetlands	67	Wetlands	**15**
Watercourses, flood protection structures	62	Watercourses	**16**
	63	Flood protection structures	
Waterbodies	61	Waterbodies	**17**