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Federal Office for the environment FOEN

Volumes of Water Withdrawn From Watercourses

The water balance of Switzerland's watercourses is most severely affected by water withdrawn for power generation. Removing large volumes of water invariably has a negative impact on watercourses, as it reduces species diversity. However, when deciding on permissible volumes of water to be withdrawn, other aspects usually weigh more heavily in the scale than ecological intactness of watercourses. As a result, withdrawn volumes of water are mostly too high from a water protection point of view. Owing to the new Federal Water Protection Act, the state of Switzerland's watercourses has been improving since 1992.

Status: February 2009

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Development in Switzerland

90% of all water withdrawn are environmentally significant because in doing so, more than half of the natural minimum river discharge is removed. If possible, severely affected watercourses must be rehabilitated by the end of 2012. For this reason, a large number of water withdrawal sites will presumably be relicensed in the years to come. The future will show if and how this will change the shares of significant and insignificant water volumes removed at water withdrawal sites licensed after 1992.

The table below lists the number of water withdrawal sites dedicated to power generation in Switzerland licensed before and after the effective date of the new Water Protection Act (WPA). In addition, the table indicates the number of water withdrawal sites that have an environmentally significant impact.

Tab. 1: Number of water withdrawal sites dedicated to power generation in Switzerland

Environmental impact	before 1992	after 1992	Total
significant	1’116	144	1’260
insignificant	137	5	142
Total number of sites	1’253	149	1’402

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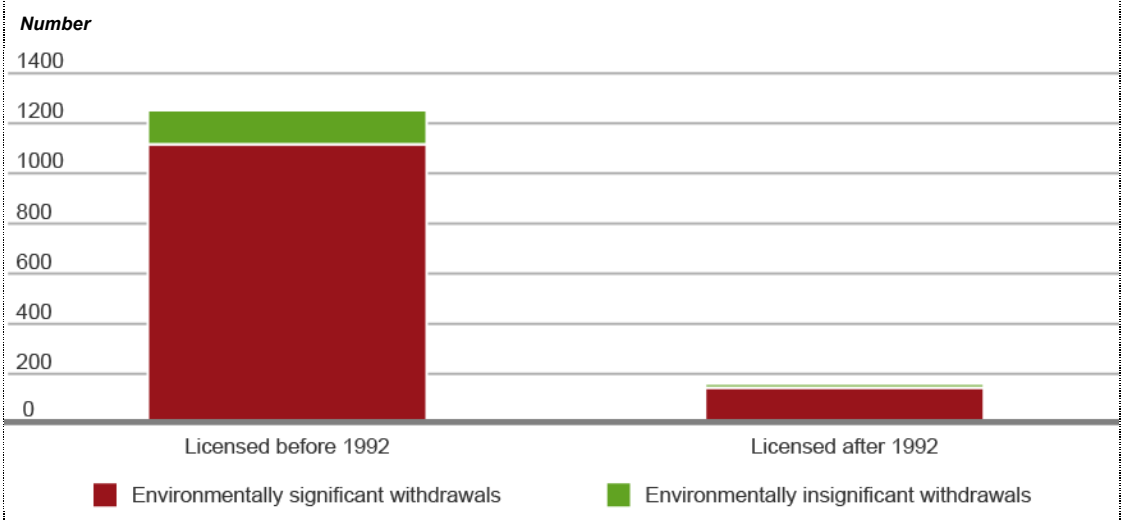
Fig. 1: Number of water withdrawal sites in Switzerland licensed before or after 1992 (effective date of the WPA)



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Comments

- Before the Water Protection Act entered into force in 1992, 1,253 water withdrawal sites for power generation were licensed, with 1’116 of them having a significant environmental impact.

- Data are based on the Map of Residual Flows in Switzerland (Kummer et al., 2007). The Map of Residual Flows records 1'406 water withdrawal sites for power generation. However, since the use is "questionable" as regards 4 of these sites, they are not included here.
- The E11 indicator monitors water withdrawals for power generation entered into the "Water Withdrawal Inventory" by Switzerland's individual cantons. Cantons collect data applying different standards of precision.
- Withdrawals amounting to more than half of the natural minimum river discharge Q_{347} (see Definition) are considered to be environmentally significant.
- The E11 indicator does not cover withdrawals from watercourses that periodically run dry, withdrawals for military purposes, and withdrawal sites that, even though legally licensed, did not have operational withdrawal equipment in late 2004.
- Since run-of-river power plants do not withdraw water, they have not been registered in the Map of Residual Flows. According to the "Statistics of Hydroelectric Power Plants in Switzerland" (Swiss Federal Office of Energy, 2008), there are 191 major run-of-river power plants with an output of more than 300 kilowatts. In addition, there is likely to be at least an equal number of small run-of-river power plants that have not been registered in the Map of Residual Flows, either.
- The largest part of today's water withdrawals had been granted before the new Water Protection Act entered into force in 1992. Most of these licenses will not expire until the period of 2030 to 2050. Withdrawal sites licensed after 1992 must guarantee residual flow volumes as stipulated by the Water Protection Act. Operators of withdrawal sites licensed before 1992 possibly observe the conditions of the Water Protection Act on a voluntary basis.
- A total of 1'402 water withdrawal sites supply 631 hydroelectric power plants. Most power plants have only one water withdrawal site, but major power plants require several. At 35 withdrawal sites, the largest number is operated by the Fionnay-Dixence power plant. Among watercourses, it is the river Linth featuring 21 withdrawal sites that scores the highest number.
- As required by the Water Protection Act (articles 80 ff), watercourses severely affected by water withdrawal must be rehabilitated by the end of 2012 if possible. For this reason, it is safe to presume that many water withdrawal sites will need to be relicensed in the years to come.
- While the Map of Residual Flows records just over 1'400 water withdrawal sites for power generation, it features only 86 water withdrawal sites dedicated to other kinds of use such as drinking water supply, artificial snow making, or cooling water.

Water withdrawal by altitudinal vegetation zone

The table below shows the number of water withdrawal sites categorized by altitudinal vegetation zone. It also indicates the point of time a withdrawal license was granted, and the number of environmentally significant water withdrawals.

Tab. 2: Number of water withdrawal sites by altitudinal vegetation zone

	Licensed before 1992					Licensed after 1992				
Altitudinal vegetation zones	**Significant withdrawals**		**Insignificant withdrawals**			**Significant withdrawals**		**Insignificant withdrawals**		
	Number	%	Number	%	Total	Number	%	Number	%	Total
Colline	165	88	23	12	188	24	100	0	0	24
Montane	533	90	60	10	593	96	96	4	4	100
Alpine/subalpine	418	89	54	11	472	24	96	1	4	25
Total of withdrawal sites	1,116	89	137	11	1,253	144	97	5	3	149

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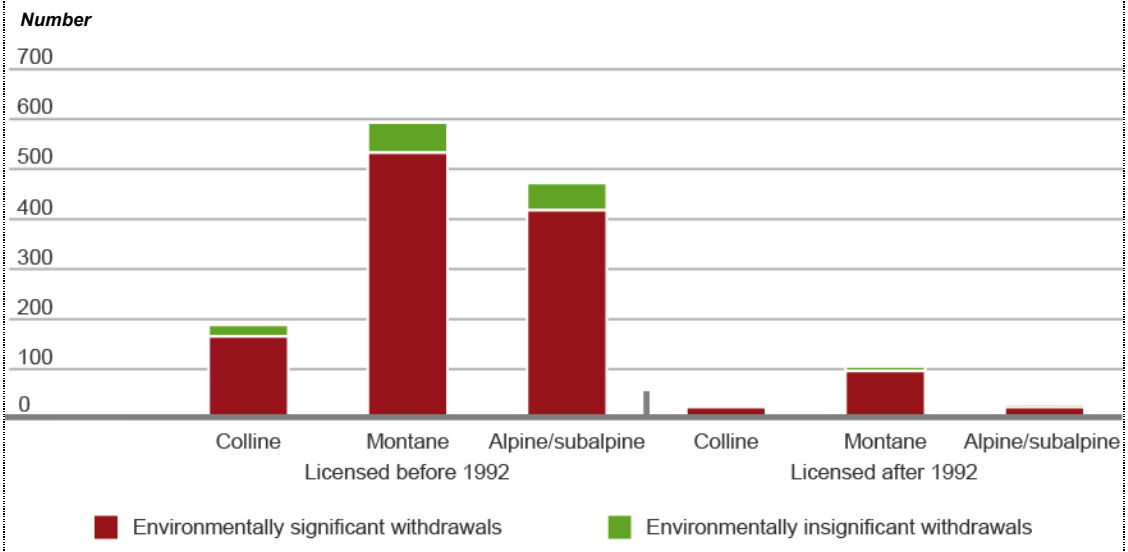
Fig. 2: Number of water withdrawal by altitudinal vegetation zone licensed before or after 1992 (effective date of the WPA)



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Significance for biodiversity

Power generation requires large volumes of water to be withdrawn from brooks and rivers, frequently resulting in water in residual flow stretches below withdrawal sites to run very low. In combination with water pollution and river bank stabilization, this development has far-reaching consequences. Of 54 native fish species, 31 are currently redlisted, and 8 have gone extinct in Switzerland (see Z5 indicator, “Change in the Endangerment Status of Species”). Besides sufficient amounts of water and good water quality,

many native fish species need intact watercourses offering them plenty of food, hiding places and spawning sites. In addition to suitable habitats, rivers are also depended upon to provide intact migration routes.

Residual flow stretches with water running low are often subject to wide temperature fluctuations, getting too hot in summer and too cold in winter. In extreme cases, residual flow stretches might even freeze in winter. Such unnatural temperature changes are likely to affect the development of numerous water organisms—in part with fatal results.

Smaller volumes of residual water also mean lower rates of discharge, causing species adapted to strong currents to lose their preferred habitat. Weaker currents allow larger amounts of suspended solids to deposit, which may severely modify the physical and chemical qualities of brook or river bottoms. When this happens, fish species such as the Trout or the Grayling, which spawn in gravel, will not find suitable spawning sites anymore. Living in gaps and cracks in stony river bottoms, other organisms such as caddisflies or stoneflies lose their entire habitat to this kind of clogging.

Residual water running too low can also cause the groundwater table to drop, since less water will seep into the subsoil. Wetlands such as reed meadows will eventually dry up due to lack of water-logging, which in turn deprives moisture-loving plants of their basis for survival, so they, too, will disappear.

Residual flow stretches that temporarily run dry have lost their value for water organisms. Such stretches are poor in species even if they run water most of the time.

It is not only significant water withdrawals that have an ecological impact on watercourses: very irregular discharges will upset the habitats of numerous water organisms as well. One third of Switzerland's watercourses is affected by swell operation of hydroelectric power plants.

In addition to negative ecological effects, extremely low amounts of residual flow also reduce the attractiveness of brooks and rivers to humans.

Sources

Umweltrecht in der Praxis, 2008: Nutzung und Schutz der Gewässer im rechtlichen Widerstreit. VUR-Tagung, 20.Mai 2008, Solothurn. 544 S.

Zaugg, C.; Leutwiler, H., 1998: Kleinwasserkraftwerke und Gewässerökologie. Situationsanalyse, DIANE 10, Klein-Wasserkraftwerke das Aktionsprogramm Energie 2000. Bern, Bundesamt für Energiewirtschaft. 82 S.

Definition

Volumes of water withdrawn from watercourses for power generation in Switzerland.

Water withdrawals amounting to more than 50% of Q_{347} are considered to be environmentally significant according to the Map of Residual Flows. Q_{347} represents the natural minimum river discharge that is reached or surpassed on 347 days of the year on average. In art. 4 litt. h of the Water Protection Act, Q_{347} is defined to be "the discharge that, averaged for ten years, is reached or surpassed on the mean number of 347 days a year without being significantly impacted by stemming, withdrawing or feeding of water".

Surveying methods

Withdrawal data for the E11 indicator "Volumes of Water Withdrawn From Watercourses" are based on the Map of Residual Flows in Switzerland (Kummer et al., 2007). Pursuant to art. 82 of the Water Protection Act, cantons are legally bound to establish an inventory of water amounts withdrawn and to

pass this information on to the Federal government. The contents of this inventory have been stipulated in art. 36 of the Water Protection Ordinance dated October 28, 1998. Data supplied by the cantons have been entered into the Federal "INVENT" database. After consulting with the technical offices in charge in the cantons, withdrawal data were updated as of the end of 2004, with cantons being responsible for data quality.

Altitudinal vegetation zones have been defined based on *"Wärmegliederung der Schweiz"* ("thermal zones of Switzerland" by Schreiber et al.). Withdrawal sites were assigned to altitudinal vegetation zones in the geographic information system GIS. Whenever an unambiguous assignment was not possible due to the location of a site (waterbody, rock, outside the Swiss border), it was assigned to an altitudinal vegetation zone in line with its altitude above sea level.

Further information

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Additional sources of information

> http://www.bafu.admin.ch/gewaesserschutz/01284/index.html?lang=en (FOEN website: water protection: residual flows)

This information is based on the German document 800 326.10 Produkt E11 V2.doc dated April 25, 2009.