

ALPINE DROUGHT OBSERVATORY

Report on the collection of drought impacts relevant for
the Alpine region: The EDII Alps V1.0 database
(D.T3.1.1)

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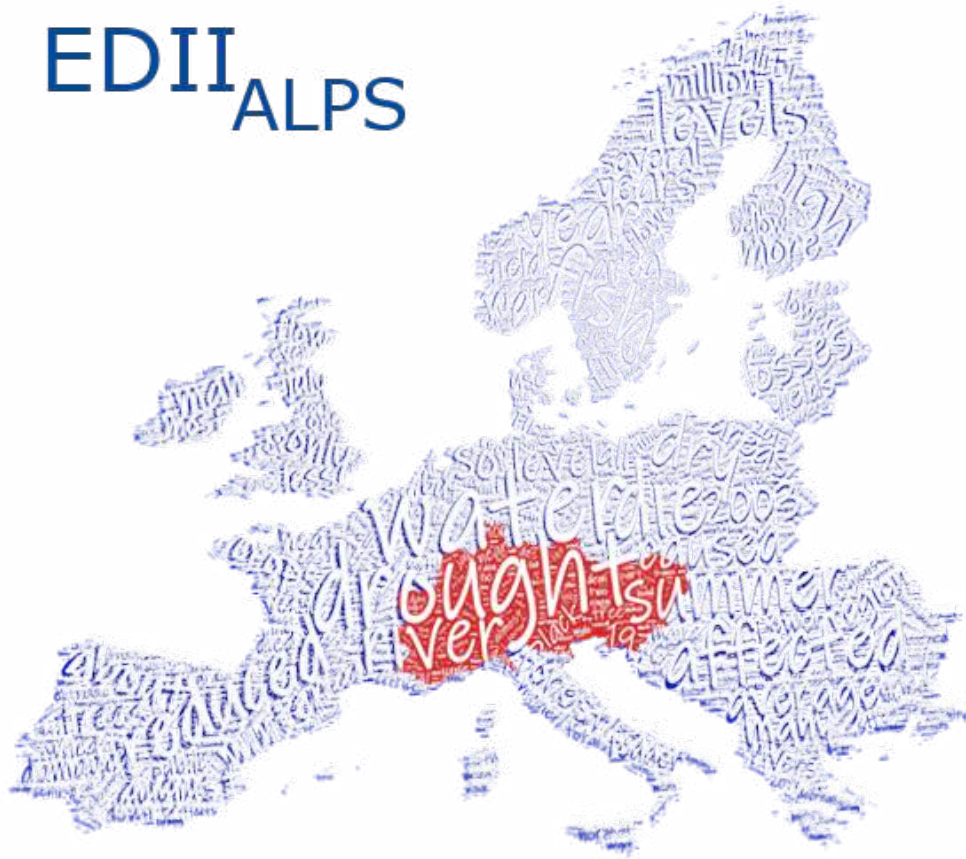
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EDII_{ALPS}



Abstract

Drought may affect a range of environmental and socio-economic sectors. Assessing a region's risk to drought requires knowledge about the type of adverse impacts that have occurred as a consequence of drought in the past. In order to improve the knowledge about potential sectors at risk in the Alpine Space region, the ADO project's aims include the collection, collation and analysis of drought impact records. This report documents the newly assembled EDII-Alps delivered by the ADO project's work package T3. This report-based drought impact inventory was built specifically for the region on the basis of the classification system of the EDII (European Drought Impact report Inventory). For the purpose of creating an up-to-date drought impact record for the region, information was gathered and transcribed from national databases and reports. Besides the most prominent impact category 'agriculture and livestock farming', many impact reports also relate to 'public water supply', 'forestry', 'aquatic ecosystems'. The report describes the data collection and provides an overview of the Version 1.0 contents of the new database, which contains more than 3200 impact entries. The data will be used for the analysis of drought vulnerability and risk in the next project phases.

Setting the impact-scene in ADO

Which social, environmental and economic sectors are affected by drought in the Alpine Space? The ADO consortium's experience regarding this question set the scene for the work package's tasks. During the first project meeting the ADO consortium shared experience and discussed the various sectors that are expected to be impacted across the Alpine Space.

A follow-up survey asked how important a range of impact categories were in the respective regions (see Tab. 1). The expert survey presented 15 categories of drought impacts covering economic, environmental and social sectors according to the European Drought report Impact Inventory (EDII) by Stahl et al. (2016). Project partners could choose among four options on country-level and NUTS 2 regions to estimate the importance of the impacted category: not relevant (0), important (1), very important (2), no information available (NA).

According to this survey the most relevant sectors were prioritized as follows:

1. Tourism and recreation,
2. Agriculture and livestock farming,
3. Energy and industry,
4. Forestry and Wildfires.

The impact categories "Soil systems" and "Air quality" received almost no votes. Therefore, the least relevant sectors according to the survey were "Soil system", "Air quality" and "Freshwater aquaculture and fisheries".

In addition, project partners assigned priorities to countries and regions. The country that is most different from all others regarding impact category votes is Italy. However, for almost all NUTS 2 regions in the Alpine Space more than ten categories were estimated to be important. For six NUTS 2 regions no estimates were given.

This first expert opinion about the relevant sectors that an Alpine Drought Observatory will need to target with its indices should be confirmed and refined based on impact data. Generally, several options exist for the collection and compilation of drought impact data:

- Text-based impact reports that are classified into categories and types, an approach that has been applied for research (Stahl et al., 2016) as well as for near real-time monitoring and mapping (e.g. www.droughtreporter.unl.edu, the US Drought Reporter).
- Quantitative data on affected sectors, for example from statistics offices. This type of data includes e.g., economic data, agricultural yields, energy production. A challenge is the attribution of any numbers such as deviations to a drought as a cause. Government compensation payment or Indemnity data (insured losses) provide more directly attributed information, but are difficult to obtain.
- Some environmental impacts, such as damage to vegetation - or proxies for them - may be monitored with remote sensing.

This report describes the deliverable of a collection of the first option: a collection of classified primarily text-based impact reports.

Table 1: Results of the survey within the ADO consortium until the 15th of February, 2020. All partners estimated how relevant the impact categories proposed by EDII (Stahl et al. 2016) are in their home region (on country-level and for all NUTS 2 region in the Alpine Space). The answers are presented with 0 = not relevant, 1 = important, 2 = very important, NA = no information available. The sums for each category and region are shown and the maxima in-between countries and NUTS 2 regions marked in red, as well as the three highest sums of the categories.

| | Agriculture and livestock farming (1) | Forestry (2) | Freshwater aquaculture and fisheries (3) | Energy and Industry (4) | Waterborne transportation (5) | Tourism and Recreation (6) | Public water supply (7) | Water quality (8) | Freshwater ecosystems (9) | Terrestrial ecosystems (10) | Soil system (11) | Wildfires (12) | Air quality (13) | Human health and public safety (14) | Conflicts (15) | Sum |
|------------------------------|---------------------------------------|--------------|--|-------------------------|-------------------------------|----------------------------|-------------------------|-------------------|---------------------------|-----------------------------|------------------|----------------|------------------|-------------------------------------|----------------|-----|
| Austria | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | NA | 2 | NA | 1 | 1 | 18 |
| Oberösterreich | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | NA | 1 | NA | 1 | 1 | 19 |
| Niederösterreich | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | NA | 2 | NA | 1 | 1 | 20 |
| Wien | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | NA | 1 | NA | 1 | 1 | 16 |
| Bugenzland | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | NA | 1 | NA | 1 | 1 | 18 |
| Steiermark | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | NA | 2 | NA | 1 | 1 | 19 |
| Kärnten | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | NA | 2 | NA | 1 | 1 | 19 |
| Salzburg | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 1 | 18 |
| Tirol | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 1 | 18 |
| Vorarlberg | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 1 | 18 |
| Switzerland | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 2 | 19 |
| Ostschweiz | 2 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | NA | 2 | NA | 1 | 2 | 17 |
| Zürich | 1 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | NA | 2 | NA | 2 | 2 | 19 |
| Nordwestschweiz | 2 | 1 | 0 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | NA | 2 | NA | 1 | 2 | 17 |
| Zentralschweiz | 1 | 2 | 0 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 2 | 17 |
| Ticino | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 2 | 2 | 18 |
| Espace Mitteland | 2 | 2 | 0 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 2 | 18 |
| Region Lémanique | 2 | 2 | 0 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | NA | 2 | NA | 1 | 2 | 18 |
| Germany | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | NA | 1 | NA | 1 | 0 | 14 |
| Freiburg | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | NA | 1 | NA | 1 | 0 | 14 |
| Tübingen | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | NA | 1 | NA | 1 | 0 | 14 |
| Schwaben | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | NA | 1 | NA | 1 | 0 | 14 |
| Oberbayern | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | NA | 1 | NA | 1 | 0 | 14 |
| France | 2 | 1 | 0 | 1 | 0 | 2 | 1 | NA | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 17 |
| Region Grand Est | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 |
| Reg. Bourg.-Franche-Comte | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 |
| Reg. Auvergne-Rhone-Alps | 1 | 1 | 0 | 1 | 0 | 2 | 1 | NA | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 16 |
| Reg. Prov.-Alpes-Cote d'Azur | 2 | 2 | 0 | 1 | 0 | 2 | 1 | NA | 2 | 1 | 0 | 2 | 2 | 1 | 1 | 17 |
| Italy | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 1 | NA | 2 | NA | 1 | 2 | 21 |
| Piemonte | 2 | 1 | NA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | NA | 1 | 0 | 0 | 2 | 13 |
| Valle d'Aosta | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 |
| Liguria | 1 | 1 | 0 | 1 | 0 | 2 | 2 | 1 | 1 | 1 | NA | 2 | 1 | 2 | 1 | 16 |
| Lombardia | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 |
| Prov. Aut. di Bolzano/Bozen | 2 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 2 | 1 | NA | 1 | 1 | 1 | 2 | 17 |
| Provincia Aut. di Trento | 2 | 1 | 1 | 2 | 0 | 2 | 1 | 1 | 2 | 1 | NA | 1 | 1 | 1 | 2 | 18 |
| Veneto | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 |
| Friuli-Venezia Giulia | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 |
| Slovenia | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | NA | 1 | 1 | 18 |
| Vzhodna Slovenija | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | NA | 1 | 1 | 18 |
| Zahodna Slovenija | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | NA | 1 | 1 | 18 |
| Sum | 58 | 52 | 13 | 55 | 38 | 61 | 37 | 34 | 38 | 26 | 3 | 50 | 9 | 34 | 41 | - |

A database of reported drought impacts

EDII-ALPS

The Alpine Drought Impact Inventory (EDII-ALPS) (Stephan et al., 2021) builds upon the European Drought Impact Report Inventory (EDII) by Stahl et al. (2016) and can be considered a subset of it that will be made accessible on the ADO platform that is being developed. The EDII was established by the EU project Drought-R&SPI for the purpose of cross-disciplinary research on drought vulnerability and risk. The inventory's objective was to compile knowledge on the impacts of historic and recent drought events from a variety of available, mainly textual, information sources. The definition of 'drought impact' follows that of previous 'impact reporters' such as the US Drought impact reporter and considers drought to be a hazard and consequently impacts to be primarily negative.

The EDII-Alps database uses the general EDII infrastructure but focuses on the specifics of the Alpine Space region. It was established in support of the analysis of relevant drought impacts in the region to help assess drought vulnerability and risk and design targeted indices for monitoring. Whether it will also be useful directly within the Alpine Drought Observatory as a near real time account of the situation will have to be determined.

The inventory's main objective is to compile knowledge on the impacts of historic and recent drought events from a variety of available information sources as this has never been done across the European Alpine region. The Alpine Space covers the Alps and their foothills, as well as different climatic zones and therefore allows the consideration of water and natural resource flow and exchange typical of mountain regions. With the region's extent, we therefore include drought impacts not only at high altitudes, but also in downstream areas of the water-rich source regions (e.g. the river basins Po, Rhine, Danube etc.).

According to EDII, EDII-ALPS archives text-based reports on drought impacts defined as follows. "A drought impact is a negative environmental, economic or social effects experienced under drought conditions." That means, precipitation shortfalls, anomalously low levels of soil moisture, water levels or stream flows alone/per se, i.e. without being associated with negative consequences (for water uses, ecosystems, agricultural yields etc.) or at least serious concerns, are not regarded as drought impacts to be registered in EDII. Observations of such direct expressions of drought (low precipitation sums etc.) and indices derived from them are not addressed in the categorization system used but will later be used as independent variables, for example to determine threshold levels that have caused certain impacts in the past - and may do so in the future. Further, no reports about expected negative drought impacts are considered, unless the report clearly indicates that this speculation actually turned out to be true.

For a drought impact report entering EDII-ALPS, it must contain the first four items of information from the following list, with the fifth item providing optional supplemental information:

1. Impact information reference, including the type of source, author, year, title, and weblink (where applicable). Information on the reported impact entered into the database should closely reflect the reference and thus be traceable and reproducible.
2. Location of reported impact with options to refer to different levels of geographical regions including the European Union NUTS regions standard.
3. Time of reported impact (at least the season of the year) and its link to a major known drought event.
4. Impact category according to the classification in Table A1 (Appendix) and short text description.
5. Associated secondary impacts, response and mitigation measures, and other relevant information that may be available.

EDII proposed 15 categories with more than 100 subtypes covering economic, environmental and social aspects impacted by drought. For EDII-ALPS we excluded EDIIs categories Soil system (11) and Wildfires (12) as the link between drought, impact and management in these categories is often inconclusive and other databases, such as the Forest Fire Information system (EFFIS, 2020) are more comprehensive. Thus, we classified all drought impact reports entering EDII-ALPS to the following 13 different categories (with 96 subtypes): Agriculture and livestock farming (1), Forestry (2), Freshwater aquaculture and fisheries (3), Energy and industry (4), Waterborne transportation (5), Tourism and recreation (6), Public water supply (7), Water quality (8), Freshwater ecosystems (9), Terrestrial ecosystems (10), Air quality (13), Human health and public safety (14), and Conflicts (15).

Data collection: contributions and sources in different countries

The latest version of EDII provided an initial core dataset to create the EDII-ALPS considering all countries within the Alpine Space. With contributions from partners in WP T3.1 (see Sect. Contributions) this dataset was updated and complemented with reports from different information sources and other existing databases located in the Alpine countries:

- (1) A broad variety of Italian newspaper articles and from labor unions,
- (2) German text-reports from media, non-governmental and governmental sources,
- (3) the French drought platform “Propluvia” (www.propluvia.developpement-durable.gouv.fr, Ministère de la Transition Écologique et Solidaire),
- (4) the Austrian chronicle of severe weather impacts “Unwetterchronik” (www.zamg.ac.at/cms/de/klima/klima-aktuell/unwetterchronik, Zentralanstalt für Meteorologie und Geodynamik),
- (5) the bulletins by the Drought Management Center for Southeastern Europe DMCSEE covering Slovenia (<http://www.dmcsee.org>, Slovenian Environment Agency) and Slovenian text reports from media (drought impacts recorded in the reports of different sectoral agencies/ organizations are not included into EDII Alps yet.)
- (6) the media archive of the Swiss information platform Drought-CH (www.drought.ch, Zappa et al., 2014).

All drought impact information reported by these sources was manually entered into the EDII-Alps. Each of them was read, assigned to a specific category, summarized in English, and entered into the database. A video tutorial was created to help all the ADO staff involved in this task.

With these updates the most impact data in the Alpine Space stem from governmental documents or reports, scientific databases and newspaper articles (see Fig. 1).

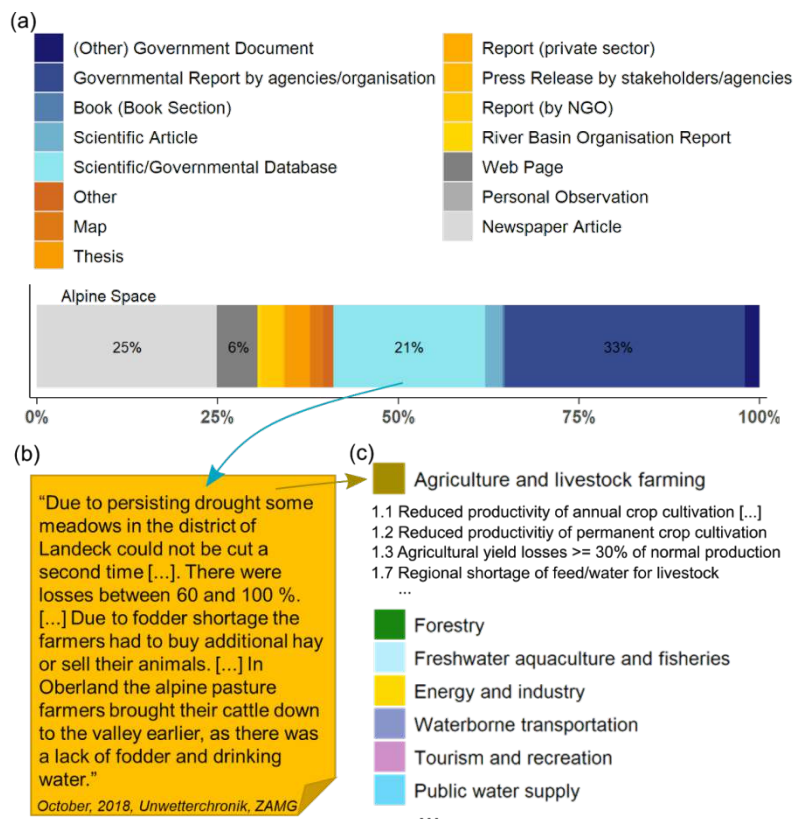


Figure 1: Schematic overview of the classified impacts in EDII-ALPS: (a) fractions of the different sources of the impact data archived in the database, (b) exemplary entry for the assigned source "scientific/governmental databases" published by the Unwetterchronik, (c) excerpt of the impact categories: the example was classified to impact category agriculture and livestock farming and the four shown subtypes.

Examples of reported impact and data entries

A few examples may illustrate the data collection and entry approach. They also reflect the expert judgement of the initial survey of relevant impacts.

Typical recorded impacts in the category "tourism and recreation" in winter is presented in the following example published by a newspaper article describing the situation in the region of Piedmont during the winter of 2000: "Drought conditions affecting winter tourism. Earlier seasonal closure for tourism facilities and emergency declaration for the mountain ski areas in Piedmont." Typical impacts in the same category, but during summer are following two examples occurred in Switzerland in 2018 and 2015: "The water level of the Greifensee sank one meter. Because of that the ships for tourists can't land on every pier (for example on the pier Mönchaltorf)" and "Fireworks on the Swiss national holiday were forbidden in many regions. In some others the distance of the firework to the forest has to be at least 200m." Both impacts were published by local newspapers.

A typical recorded impact in the category "agriculture and livestock farming" is described in the following example published in August, 2003, by the Austrian centre for agricultural information. Further the impact description is a good example to illustrate that one description can be recorded for several impacts classified by specific subtypes of the category: "In some regions in lower Austria the grain harvest was less than 50 %, especially for wheat and canola. [...] The first cut of grasslands summed up to only two thirds of the normal yield [...]." This first part of the description provided the basis to assign the subtypes "reduced productivity of annual crop cultivation [...]" (1.1) and "agricultural yield losses >= 30 % of normal production [...]" (1.3). The description continues as follows: "Costs

for irrigation were higher.” This part leads to the additional subtype “increased costs/economic losses (1.9)”. The last part of the description says: “The federal state of lower Austria supported the farmers with 1.5 million euros for the so-called ‘Feeding stuff acquisition’ [...]” This is not added as a further impact, but noted in the section “Response and mitigation strategies”.

Cattle grazing on high-elevation pastures is an important and traditional practice in the entire Alpine Space that may be affected by drought. An exemplary summarized description to a related drought impact on management of livestock on higher-elevated pasture was published in October, 2018 by the Unwetterchronik: “Due to persisting drought some meadows in the district of Landeck could not be cut a second time [...]. There were losses between 60 to 100 %. [...] Due to fodder shortage the farmers had to buy additional hay or sell their animals. [...] In Oberland the alpine pasture farmers brought their cattle down to the valley earlier, as there was a lack of fodder and drinking water.” This description led to four different impact subtypes (see Fig. 1).

However, reports also concern impacts outside those identified as most relevant by the expert survey. A typical example related to public water supply for non-essential uses is the following report published in July, 2015 by a regional Italian newspaper: “In Trento fountains were closed. At the Arco municipality drought conditions are severe with water use bans. The civil protection monitors the level of the Lago delle Piazze, where different sectoral water demands can quickly worsen the current conditions.”

In contrast to the media and chronicle sources, the French platform “Propluvia” offered mapped management strategies across France, classified by increasing warning levels dependent on the drought severity. For example, the warning level ‘reinforced alert’ means that in the mapped region bans on watering gardens/lawns, open spaces, golf courses, and washing the car at certain times are taking place. Further, the reduction of withdrawals for agricultural purposes less than or equal to 50 % and measures prohibiting valve operations and nautical activity are applied. This way, Propluvia provides information about negative drought impacts with specific measures for the society and economy that could be translated into EDII database entries.

Content of Version 1.0

At the time of release of Version 1.0 (January 2021) the EDII-ALPS’ content summed up to more than 3200 reports on drought impacts. The amount of collected and archived drought impact reports varies for the different countries and NUTS-2 regions. The largest number of reports that could be entered into the database describes impacts in the French part of the Alpine Space, thanks to the entries sourced from the Propluvia database. The fewest entries are currently located in Italy, where no prior database was available and reports had to be searched in the media and other sources (see Fig. 1). The overall numbers are biased to the search efforts and report availability and should not be mistaken with a proneness to drought or with overall vulnerability to drought. The bias is exemplified by the many reports at NUTS-3 level in Freiburg (n=311), where the authors are located and routinely enter information to the database. The least entries at this finest spatial scale have been collected for Friuli-Venezia Giulia (n=4).

The majority of the impacts in EDII-ALPS relates to the category “Agriculture and livestock” farming followed by “Public water supply” (Fig. 2). These two impact categories account for more than two thirds of the whole database. Substantially less, but ranking third and fourth, “Forestry” and “Freshwater ecosystems” are also among the most reported sectors in the Alpine Space. Despite the dominance of drought impacts related to agriculture and livestock farming, the impacts’ diversity of the region is well represented in the database, which contains impacts related to 13 different categories covering different aspects from society over economy to ecology.

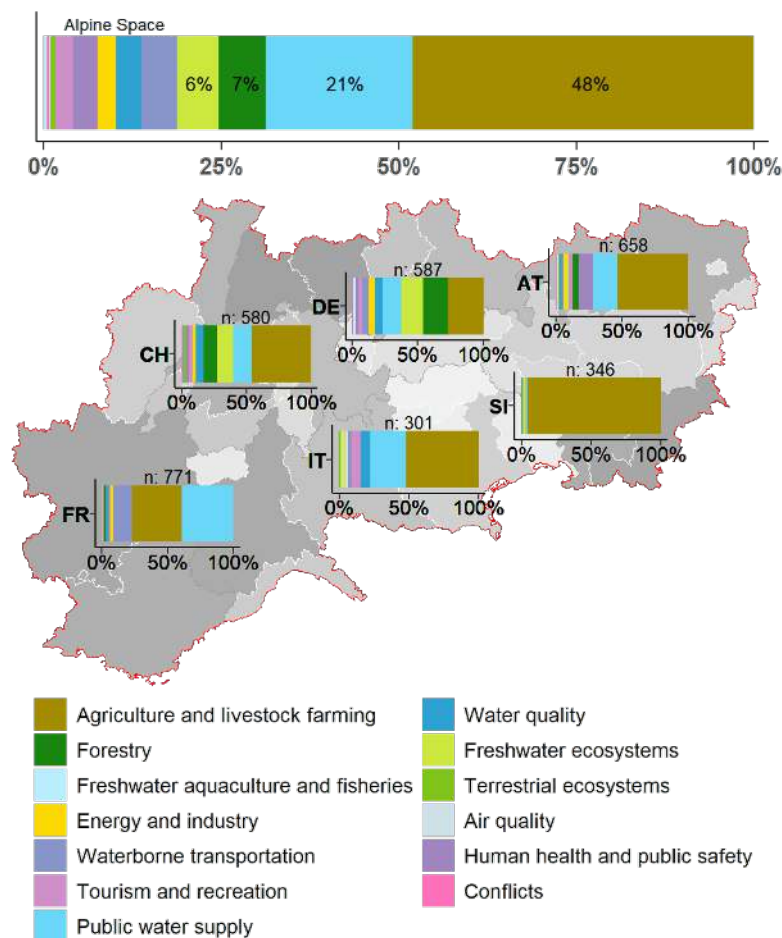


Figure 2: Fractions of impact records in the different impact categories in EDII-Alps Version 1.0: for the whole Alpine Space (top barplot) and by country (lower map). Darker grey shading relates to a higher count of reports per NUTS 2 region.

While this report's aim is the presentation of the data collection and database and not a detailed analysis (this will be the next step), a few summary statistics are provided. There are notable differences among the Alpine countries respectively the part of the country within the Alpine Space (Fig. 2). The French region is dominated by impacts related to "Public water supply", whereas all the other countries show the highest fraction of reports related to "Agriculture and livestock farming". Slovenia stood out with more than 96 % of all reports related to this category. In contrast, the German region showed the smallest fraction of Agriculture and livestock farming, but still it is the first rank. The second highest fraction here are impacts related to Forestry (19 %), a high rank of this sector that is not reached by any other country. For the third rank in the German part we identified the category Freshwater ecosystems (17 %), which is analogous to Switzerland with a slightly lower fraction (13 %). In Austria, Italy and Switzerland "Public water supply" is the second most reported category with the highest fraction in Italy that is only exceeded by the French part.

Most reports could be classified with the existing classification system. We identified one relatively typical impact type that had not yet been considered specifically in the classification system. Several reports described a lack of water respectively snow limiting the preparation and grooming of ski slopes and cross-country ski trails. Subsequently, closed ski resorts, increased costs or shifted season openings impaired the winter tourism substantially. To cover these impacts we introduced an additional subtype in the category "tourism and

recreation” named “impaired use of ski slopes and cross-country ski trails due to lack of snow/water (e.g. limited snow production, impaired grooming) (6.7)”. However, the amount of reports in this and the other subtypes of the category “tourism and recreation” did not confirm the overall perceived first rank importance presented in the expert survey described in section 1. The report collection in EDII-ALPS ranked this category on the 9th position. Reports on some sectors such as energy production have so far been difficult to obtain for all countries and similar to wildfires for example are difficult to attribute directly to drought.

An excerpt of the actual database is shown in Table A2 (Appendix) and the data will be integrated into and accessible through the ADO platform. The data was used in a first spatial and temporal analysis, which can also be seen in Stephan et al. “An Alpine Drought Impact Inventory to explore past droughts in a mountain region”, a journal article submitted to NHESS (Stephan et al., 2021).

Conclusion

The ADO project successfully collected information on drought impacts across the Alpine Space. Several national databases as well as as a general media and report search allowed to assemble and archive more than 3000 reported drought impacts in a common database that is called EDII-Alps Version 1.0. Overall, the priority of sectors from the expert survey is partly reflected by the volume of reported impacts. Impacts on sectors such as tourism, perceived as very important for the ADO consortium have been reported, though less often. Impacts on agriculture, water supply, forestry rank high among the reports collected. The data provide an overview of the affected sectors in the past. For quantitative environmental and economic analyses of impacts additional data sources will be necessary, but the assembled archive can serve as a basis for detection and understanding of the impacts of drought on the region. The impact data may also serve as indicators of past vulnerability and for validation exercises of the usefulness of impact-targeted drought indices on the ADO platform. Potentially, the database system might be developed further into a real-time impact reporter.

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Appendix

Table A1: Impact categorization scheme of EDII and EDII-Alps (Stahl et al. 2016).

| Impact category | Impact type | |
|--------------------------------------|-------------|--|
| | EDII-ID | Description |
| Agriculture and livestock farming | 1.1 | Reduced productivity of annual crop cultivation: crop losses, damage to crop quality or crop failure due to dieback, premature ripening, drought-induced pest infestations or diseases etc. |
| | 1.2 | Reduced productivity of permanent crop cultivation |
| | 1.3 | Agricultural yield losses \geq 30% of normal production (EU compensation threshold) |
| | 1.4 | Reduced availability of irrigation water |
| | 1.5 | Reduced productivity of livestock farming (e.g. reduced yields or quality of milk, reduced stock weights) |
| | 1.6 | Forced reduction of stock(early selling/slaughtering) |
| | 1.7 | Regional shortage of feed/water for livestock |
| | 1.8 | Other |
| | 1.9 | Increased costs/economic losses |
| Forestry | 2.1 | Reduced tree growth and vitality |
| | 2.2 | Decrease in annual non-timber products from forest trees (e.g. cork, pine nuts, mushrooms, berries, etc.) (please specify which kind of product) |
| | 2.3 | Increased occurrence of water stress indicators and damage symptoms (e.g. premature ripening, seasoning checks, defoliation, worsened crown conditions etc.) (please specify forest type/tree species in the description field!) |
| | 2.4 | Increase of pest/disease attacks on trees (please specify species in the description field!) |
| | 2.5 | Increased dieback of trees (please specify tree species in the description field!) |
| | 2.6 | Increased dieback of planted tree seedlings (in nurseries or afforested area) |
| | 2.7 | Damage to short rotation forestry plantations (energy forestry) |
| | 2.8 | Other |
| | 2.9 | Increased costs/economic losses |
| Freshwater aquaculture and fisheries | 3.1 | Reduced (freshwater) fishery production (please specify fish species in the description field) |
| | 3.2 | Reduced aquaculture production (please specify fish species in the description field) |
| | 3.3 | Other |
| | 3.4 | Increased costs/economic losses |
| Energy and industry | 4.1 | Reduced hydropower production |
| | 4.2 | Impaired production/shut down of thermal/nuclear power plants (due to a lack of cooling water and/or environmental legislation for discharges into streams) |
| | 4.3 | Restriction/disruption of industrial production process (due to a lack of process water and/or environmental legislation/restrictions for discharges into streams) |
| | 4.4 | Other |
| | 4.5 | Increased costs/economic losses |
| Waterborne | 5.1 | Impaired navigability of streams (reduction of load, increased need of interim storage of goods at ports) |

| Impact category | Impact type | |
|--|-------------|---|
| | EDII-ID | Description |
| transportation | 5.2 | Stream closed for navigation |
| | 5.3 | Other |
| | 5.4 | Increased costs/economic losses |
| Tourism and recreation | 6.1 | Reduced number of short-stay-tourists |
| | 6.2 | Reduced number of long-stay-tourists |
| | 6.3 | Sport/recreation facilities affected by a lack of water |
| | 6.4 | Impaired use/navigability of surface waters for water sport activities (including bans) |
| | 6.5 | Other |
| | 6.6 | Increased costs/economic losses |
| Public water supply | 7.1 | Local water supply shortage / problems (drying up of springs/wells, reservoirs, streams) |
| | 7.2 | Regional/region-wide water supply shortage/problems (drying up of springs/wells, reservoirs, streams) |
| | 7.3 | Bans on domestic and public water use (e.g. car washing, watering the lawn/garden, irrigation of sport fields, filling of swimming pools) |
| | 7.4 | Limitations in water supply to households in rural areas (supply cuts, need to ensure water supply by emergency actions) |
| | 7.5 | Limitations in water supply to households in urban areas (supply cuts, need to ensure water supply by emergency actions) |
| | 7.6 | Other |
| | 7.7 | Increased costs/economic losses |
| Water quality | 8.1 | Increased temperature in surface waters (close to or exceeding critical values) |
| | 8.2 | (Temporary) water quality deterioration/problems of surface waters(natural & manmade); e.g. significant change of physio-chemical indicators, increased concentrations of pollutants, decreased oxygen saturation levels, eutrophication, algal bloom) |
| | 8.3 | (Temporary) impairment of ecological status of surface waters (according to EU Water Framework Directive) |
| | 8.4 | (Temporary) impairment of chemical status of surface waters (according to EU Water Framework Directive) |
| | 8.5 | Increased salinity of surface waters (saltwater intrusion and estuarine effects) |
| | 8.6 | Problems with groundwater quality |
| | 8.7 | Increased salinity of groundwater |
| | 8.8 | Problems with drinking water quality (e.g., increased treatment, violation of standards) |
| | 8.9 | Problems with bathing water quality |
| | 8.10 | Problems with irrigation water quality |
| | 8.11 | Problems with water quality for use in industrial production processes |
| | 8.12 | Other |
| | 8.13 | Increased costs/economic losses |
| Freshwater ecosystems: habitats, plants and wildlife | 9.1 | Increased mortality of aquatic species (specify species (latin term) and state whether a rare/endangered/protected species is concerned in the description field) |
| | 9.2 | Increased species concentration near water |
| | 9.3 | Migration and concentration (loss of wildlife in some areas and too many in others) |
| | 9.4 | Increased populations of invasive (exotic) aquatic species |
| | 9.5 | Observation of adverse impacts on populations of rare/endangered (protected) riparian species |

| Impact category | Impact type | Description |
|---|--------------------|---|
| | 9.6 | Observation of adverse impacts on populations of rare/endangered (protected) species of wetlands |
| | 9.7 | Loss of biodiversity (decrease in species diversity) |
| | 9.8 | Danger for or actual violation of minimum flow or environmental flow requirements |
| | 9.9 | Drying up of shallow water areas, weed growth or algae bloom |
| | 9.10 | Drying up of perennial stream sections |
| | 9.11 | Drying up of lakes and reservoirs (which have a habitat function) |
| | 9.12 | (Mid-/Long-term) deterioration of wetlands |
| | 9.13 | Irreversible deterioration/loss of wetlands |
| | 9.14 | Other |
| | 9.15 | Increased costs/economic losses |
| Terrestrial ecosystems: habitats, plants and wildlife | 10.1 | Increased species mortality (specify species (latin term) and state whether a rare/endangered/protected species is concerned) |
| | 10.2 | Changes in species biology/ecology |
| | 10.3 | Loss of biodiversity (decrease in species diversity) |
| | 10.4 | Shift in species composition |
| | 10.5 | Reduced plant growth |
| | 10.6 | (Mid-/Long-term) deterioration of habitats |
| | 10.7 | Irreversible deterioration/loss of habitats |
| | 10.8 | Lack of feed/water for terrestrial wildlife |
| | 10.9 | Increased attacks of pests and diseases |
| | 10.10 | Increased contact of wild animals under stress (shortage/lack of feed and water) with humans/human settlements |
| | 10.11 | Other |
| | 10.12 | Increased costs/economic losses |
| Soil system | 11.1 | Drought-related erosion processes (loss of soil fertility) |
| | 11.2 | Structural damage to private property due to soil subsidence/shrinkage |
| | 11.3 | Structural damages on infrastructures due to soil subsidence/shrinkage |
| | 11.4 | Other |
| | 11.5 | Increased costs/economic losses |
| Wildfires | 12.1 | Increased burned area |
| | 12.2 | Increased number of wildfires |
| | 12.3 | Increased severity of wildfires |
| | 12.5 | Increased costs/economic losses |
| | 12.6 | Other |
| Air quality | 13.1 | Air quality pollution effects/problems (dust bowl effect, wildfires, substitution of hydropower production by fossil energy) |
| | 13.2 | Other |

| Impact category | Impact type | |
|--------------------------------|-------------|--|
| | EDII-ID | Description |
| | 13.3 | Increases costs/economic losses |
| Human health and public safety | 14.1 | Heat stress problems (if drought is associated with a heatwave) |
| | 14.2 | Increased respiratory ailments (heat wave and air quality) |
| | 14.3 | Excess mortality during heat waves |
| | 14.4 | Drought induced public-safety issues (e.g. increased risk of structural damages) |
| | 14.5 | Other |
| | 14.6 | Increases costs/economic losses |
| Conflicts | 15.1 | Water allocation conflicts – international |
| | 15.2 | Regional/local user conflicts |
| | 15.3 | Other |
| | 14.4 | Increases costs/economic losses |

Table A2: Excerpt of archived entries by EDII-ALPS. The least required information is shown in four main columns: Reference, Location, Time (start), and Impact classification. Each presents further information by: Entry ID identifies the entry, Source ID assigns the source type, Reference provides the source itself with a title, link etc., Country displays the CNTR code of the country in which the impact occurred, NUTS 1, NUTS 2, NUTS 2, Rivers, streams, Lakes, reservoirs presents further information about the impacts location, Month, Season and Year provides information about the timing of the impact (here restricted to the start of the time-period), Impact category and Impact subtypes shows one classification the impact description led to, Impact description displays a short summary of the original text provided by the reference. This excerpt does not display any further information, such as associated impacts or response measures.

| Reference | | Location | | | | Timing (start) | | | Impact classification | | | | | |
|----------------|-----------|--|---------|--------|--------|----------------|-----------------|-------------------|-----------------------|--------|------|-----------------|----------------|--|
| Entry ID | Source ID | Reference | Country | NUTS 1 | NUTS 2 | NUTS 3 | Rivers, streams | Lakes, reservoirs | Month | Season | Year | Impact category | Impact subtype | Impact description |
| de_41116_156 | 8 | UNEP, 2004. Impacts of Summer 2003 Heat Wave in Europe, Environment Alert Bulletin 2 no.2, United Nations Environment Programme, Nairobi. http://www.grid.unep.ch/products/3_Reports/ew_heat_wave.en.pdf | FR | FRK | FRK2 | FRK22 | Seine | | 8 | | 2003 | 4 | 4,2 | An exceptional exemption from the legal requirements was granted to six nuclear reactors and a number of conventional power stations: The nuclear power plants of Nogent-sur-Seine (Aube) continued functioning, although the upper legal limits were exceeded. |
| BK_44089_16194 | 5 | Historical overview of drought impact records in Slovenia, Internal report of the DMCSEE Project (SEE/A/091/2.2/X), Ljubljana, August 2010 http://www.archiviolastampa.it/component/option,com_lastampa/task,search/mod,libera/action,viewer/Itemid,3/page,7/articleid,0088_01_1962_0199_0007_17374380/ | SI | SI0 | SI03 | SI034 | Savinja, Sotla | Šmartinsko jezero | | Summer | 1988 | 1 | 1,2 | Severe drought reduced hops yield by 20-25%. Saline water intrusions at the Po delta (30 km inland saline intrusion) caused damages to agriculture, fisheries (fish species not specified) and to water supply for domestic purposes. |
| ak_44227_18231 | 4 | | IT | ITH | ITH3 | | Po | | | Summer | 1962 | 3 | 3,1 | Big hotel ships cannot navigate anymore between Straubing and Passau because off the low water level. The cargo ships have to reduce their load. |
| ak_44227_18216 | 14 | Bayern (09.08.2018): Schifffahrt sitzt auf dem Trocken | DE | DE2 | DE21 | | Danube | | | Summer | 2018 | 5 | 5,1 | Drought affects the agricultural production in Piedmont with losses of around 120 millions of euro. Consequences on the agricultural production in Veneto, Emilia-Romagna and Sardinia. Effects of reduced alpine meadows growth in Piedmont and saline intrusion on the Veneto coast. Prolonged drought conditions affecting annual crop irrigation and production. Limitations in water supply and tanks coming from areas with more water provision to compensate low water availability in different town of the region. Spread of wildfires with Canadair and teams working to extinguish them. |
| ak_44227_18219 | 4 | https://www.repubblica.it/2006/06/sezioni/cronaca/grande-secca-po/grande-secca-po/grande-secca-po.html?ref=search | IT | ITC | ITC4 | | | | | Summer | 2006 | 1 | 1,1 | |
| ak_44227_18221 | 9 | http://www.nimbus.it/meteonews/meteodiario/diariometeomarzo.htm | IT | ITC | ITC1 | | | | | Spring | 2000 | 7 | 7,1 | |

| Reference | | Location | | | Timing (start) | | | Impact classification | | | | | | |
|--------------------------|-----------|--|---------|--------|----------------|--------|-----------------|-----------------------|-------|--------|------|-----------------|----------------|--|
| Entry ID | Source ID | Reference | Country | NUTS 1 | NUTS 2 | NUTS 3 | Rivers, streams | Lakes, reservoirs | Month | Season | Year | Impact category | Impact subtype | Impact description |
| AH_4236 0_6211 | 4 | http://www.sueddeutsche.de/muenchen/folgen-derrekordtroekendheitdiewuestelebt1.1198104 | DE | DE2 | DE21 | | Isar | | 11 | | 2015 | 4 | 4,1 | The low water level at the Isar causes a reduced hydropower production. The "Eon Wasserkraft GmbH" has economic losses about 10%. The Isar can even be crossed by feet. |
| AH_4242 8_6443 | 4 | http://www.swp.de/schwaebisch_hall/lokales/schwaebisch_hall/art1188139,3375109 http://derstandard.at/2000020769592/Verbund-erzeugte-im-Juli-ein-Fuenftel-weniger-Wasserkraft-Strom?ref=rss | DE | DE1 | DE13 | | | | | Summer | 2015 | 8 | 8,2 | Surface waters in the Landkreis Schwäbisch Hall have high pollutant concentration, low oxygen contents and high temperatures because of real low water levels. The hydropower concern of Vienna had a reduction of hydropower production at the Danube about 30% under the longterm average. |
| AH_4242 1_6397 | 4 | http://www.sueddeutsche.de/muenchen/folgen-derrekordtroekendheitdiewuestelebt1.1198104 | AT | AT1 | AT12 | | Danube | | 7 | | 2015 | 4 | 4,1 | After 40 days without precipitation in Kärnten the fire brigade had to support private households with water. The first cut for hay was almost missing. Thus, The fodder for the animals in milk production is missing. As well, complete losses for spring barley are reported. |
| RueS_44 103_160 45 | 1 | Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Umweltchronik | AT | AT2 | AT21 | | | | 4 | | 2015 | 7 | 7,2 | Lack of snow cover and rainfall in winter affecting the level of artificial lakes with restrictions in the use of public water already in spring 2017. |
| RueS_44 103_160 46 | 1 | Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Umweltchronik | AT | AT2 | AT21 | | | | 4 | | 2015 | 1 | 1,1 | Water emergency in Friuli-Venezia-Giulia for the agricultural production. The regional government requested to reduce the minimum ecological flow requirement in order to provide enough water for croplands |
| ST_4401 8_15992 | 4 | https://www.pressreader.com/italy/corriere-del-trentino/20170426/281560880682985 | IT | ITH | ITH2 | | | | | Spring | 2017 | 7 | 7,3 | The November in Bavaria had been one of the driest in history and there had been no rain for several weeks. As consequence, the water channel level of the Danube between Straubing and Vilshofen sank to 1,30m. Boats can only pass with a reduced load. |
| ST_4402 2_16009 | 4 | http://www.archiviola stampa.it/component/option,com_lastampa/task,search/mod.libera/action,viewer/Itemid,3/page,14/articleid,0165_01_2003_0189_0014_1144736/ | IT | ITH | ITH4 | | | | | Summer | 2003 | 9 | 9,8 | |
| AH_4236 0_6210 | 4 | http://www.sueddeutsche.de/muenchen/folgen-derrekordtroekendheitdiewuestelebt1.1198104 | DE | DE2 | DE21 | | Danube | | 11 | | 2015 | 5 | 5,1 | |