Cost-Benefit Analysis

Flood Management Use Case

The Added Value of 3D Geo-information

ConsultingWhere
Maximising the value of location information

EuroSDR

Scope of Use Case

- **Costal flooding : tsunami, combination of large tide / strong swell / strong wind**

Xynthia storm (53 dead people in Fra
February 27th 28th 2010

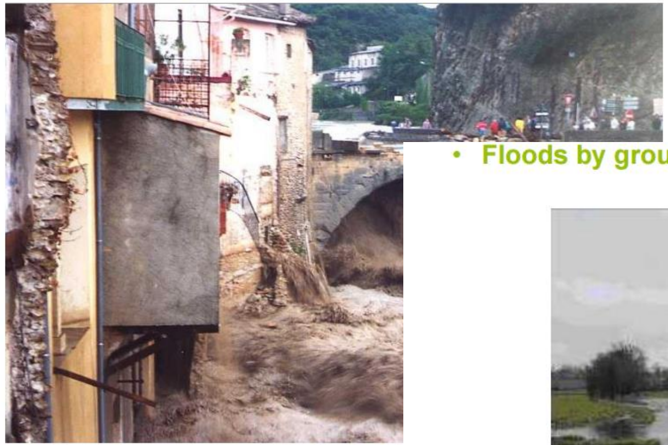
3

- **Overflowing rivers (Seine, Loire, Rhône, etc.)**

Alexander IIIrd Bridge, Paris June 4

4

- **Floods by runoff (combination of heavy rains / storms and relief)**



Nîmes (1988), Vaison-la-Romaine (19
'2010) ,Alpes-Maritimes (2015) etc

- **Floods by groud water level rises**

6

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Summary

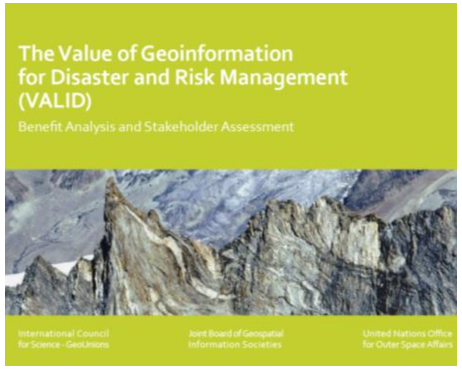
- Three approaches were developed for assessing the cost-benefit:
  1. Cost Avoidance
     - Based on the approach advocated by the United Nations study on The Value of Geo-information for Disaster and Risk Management (VALID)
  2. Case study evidence
     - Same approach as used for urban planning
  3. Benefits transfer
     - Uses evidence National Enhanced Elevation Assessment (NEEA) - a large comprehensive study from the United States to infer benefits to European countries.

Option 1: Cost Avoidance

Option 1: Cost Avoidance

Based on UN study

- A copy is available on BaseCamp



It evaluates the damages and losses that could have been avoided had an information product been used other than the one currently implemented.

The avoided damages are then interpreted as the benefits of this product.

It has the advantage of requiring only limited information:

(i) Historical information on the loss and damage from previous events

- this is usually available from public sources but can if necessary be obtained by a Freedom of Information request

(ii) Interviews with experts to indicate the positive effects of a high accuracy DTM

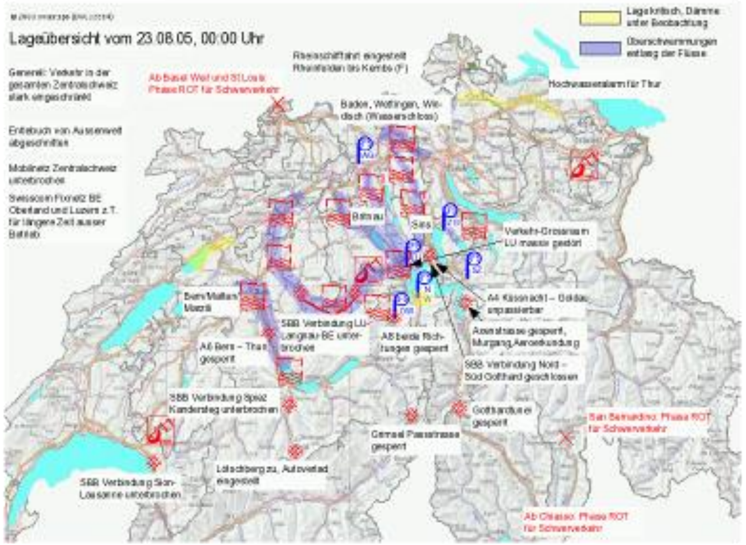
Flooding 2005


Reussdelta


Oey


Engelberg


Giswil

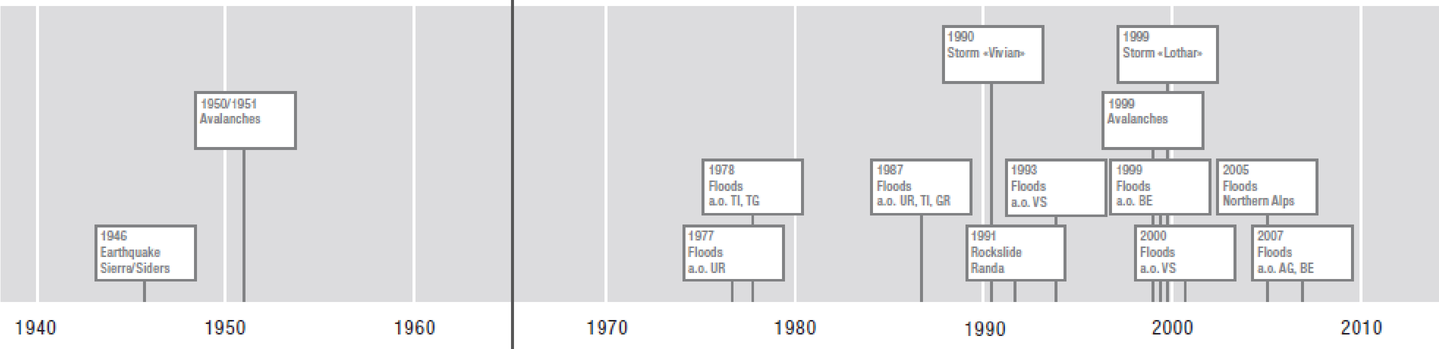



Bern

Key hazard events

This document concerns the approach adopted to natural hazards, in particular **flood protection** (floods, bank erosion, debris flows), **avalanche protection, mass movements** (fall, slide and flow processes) and **earthquakes**, in Switzerland.

It does not cover the hazards arising from technological and industrial structures and plants or from accidents. However, given that major accidents can be triggered by the aforementioned natural hazards, it is important to note that interactions with these phenomena may arise.



Earthquakes

The first seismic hazard analyses and applications of seismic engineering arose in the context of the construction of dams and nuclear power plants in Switzerland in the 1960s.

However, building standards containing adequate modern seismic regulations for structures and plants were not published until 1989 in Switzerland. These standards were largely ignored initially and the implementation of earthquake-related **preventive measures** did not begin in Switzerland until the mid-1990s. The reason for this was the increased awareness triggered by the severe earthquakes that occurred in California (San Francisco 1989, Los Angeles 1994) and Japan (Kobe 1995).

Although Switzerland is a country with moderate earthquake activity and although the seismic hazard is classified as average, **strong earthquakes** can cause significantly greater damage than other natural hazards. The risk (probability × extent of damage) posed by earthquakes is comparable to that posed by flooding.

Avalanches

The avalanche winter of 1950/1951 marked the birth of modern avalanche defence with the installation of industrially manufactured and standardized **barrier structures** in avalanche release areas.

A detailed event analysis (report on winter 1950/51) also laid the foundations for the targeted and continuous collection of meteorological data and information about the snow cover structure – and hence also the basis for today's **avalanche forecasts.**

At the same time, the realisation prevailed that adequate avalanche safety cannot be achieved through structural, biological (protective forest maintenance, afforestation) and organisational measures, but that **spatial planning instruments** are also required.

This led to the development of the first avalanche hazard map (Gadmen 1954, Wengen 1960), on the one hand, and the establishment of a crucial legislative basis at federal level in 1965, on the other. This law obliges the cantons to develop avalanche zone plans so that areas at risk from avalanches are not subject to further development.

Forest maintenance

Up to the second world war, the high demand for wood ensured extensive forest management, including on **steep slopes.** Some protective forests were even overlogged. With the increased use of fossil fuels and alternative construction materials (concrete, plastic), forest management was gradually limited to more easily managed areas. As a result, the abandoned protective forests became increasingly dense and dark and the forests were not regenerated.

Changes unfold very slowly in forests, particularly in high-altitude mountain forests. Hence it took decades for the **negative impacts** of this development (loss of stability, tendency for large-scale forest collapse etc.) to become evident.

Protective forest maintenance was not defined as a public duty until the advent of the waldsterben (forest death) debate of the mid-1980s and has also been financed using federal subsidies since then.

Mass movements

Because water is a crucial factor in triggering slope instability, the **water balance** plays a key role in the occurrence of mass movements. High precipitation intensities during extreme weather events caused a large number of slope instabilities and slope-type debris flows in recent year Locations in geologically vulner areas dominated by flysch rock molasse rock, slate or fine-grai slope debris are particularly pro to mass movements. Existing sl instabilities can be reactivated a result of changes in the water balance (climate change).

Climate change has now beco quantifiable and will also influe temperature and precipitation i Switzerland. The **disappearanc of the glaciers** and **thawing of the permafrost** will also tak effect – locally and in the long term – in the Alpine regions.

Floods

By the aftermath of the storm events of 1987, at the latest, it became clear that structural measures alone are not sufficient to guarantee flood protection.

Since then **spatial planning** (master planning and land-use

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of the Environment, Transport, Energy and Communications DETEC
Federal Office for the Environment FOEN
Hazard Prevention Division

September 2011

Living with Natural Hazards

Objectives and priorities for action of the Federal Office for the Environment (FOEN) in dealing with natural hazards

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This publication is also available in German and French

Natural Hazards

Lage
Lebensretten
Lebesparen

Dokumentation
Erstattung €€
Massnahmen

The worst natural disasters in Switzerland since 1356 and their consequences

T13.1 Die schwersten Naturkatastrophen seit 1356 und ihre Folgen

			Tote	Millionen Franken
	1356	Erdbeben von Basel	100–2000	–
	1618	Erdrutsch von Plurs (GR)	930	–
	1806	Bergsturz von Goldau (SZ)	500	–
	1830	Unwetter im Hauensteingebiet (Hochwasser)	19	–
	1852	Hochwasser	–	1000
	1855	Erdbeben von Brig-Visp (VS)	1	5
	1868	Überschwemmungen im Alpenraum	50	14*
	1876	Hochwasser (Mittelland und Voralpen)	–	14*
	1881	Bergsturz bei Elm (GL)	115	–
	1910	Überschwemmungen Zentral- und Ostschweiz	27	16*
	1927	Hochwasser (Tessin und Graubünden)	12	10,5*
	1947	Dürresommer	–	–
	1951	Lawinenwinter	97	120
	1978	Unwetter (Hochwasser)	–	1000
	1987	Hochwasserereignisse im Uri	1	1100
swisstopo	1990	Sturm Vivian	–	–
swisstopo	1993	Hochwasserereignisse im Wallis (Brig)	2	750
	1999	Hochwasserereignisse im Mittelland	2	620
swisstopo	1999	Lawinenwinter	17	750
swisstopo	1999	Sturm Lothar	14	1700
	2000	Überschwemmungen im Wallis und im Tessin	16	710
	2002	Unwetter	0	190
	2003	Dürre- und Hitzesommer	975	100
swisstopo	2005	Hochwasserereignisse in 13 Kantonen	6	3000
	2007	Hochwasserereignisse in den Kantonen Aargau, Solothurn, Basel-Landschaft, Bern und Waadt	1	380
	2007	Sturm Kyrill	0	–
	2007	Überschwemmungen in den Voralpen der Alpennordseite	0	–

* Nominal
– Nicht bekannt

Quelle: BAFU

*Umwelt Schweiz 2009 (BAFU)

Chronology of the major natural disasters in Switzerland

- Natural disasters have been happening in Switzerland since time immemorial, and the earliest records date back to the 13th century. With urban areas becoming increasingly densely populated and material assets becoming ever more valuable, the scale of damage caused by comparable natural disasters has risen dramatically over the past few decades.

- PLANAT (http://www.planat.ch/en/home/), the national platform for natural hazards, has an overview of historical events, with the major natural disasters in Switzerland listed chronologically, and illustrated by a wealth of supplementary pictures and videos.
- Chronology of the major natural disasters in Switzerland (http://www.planat.ch/en/knowledge-base/chronicle/).

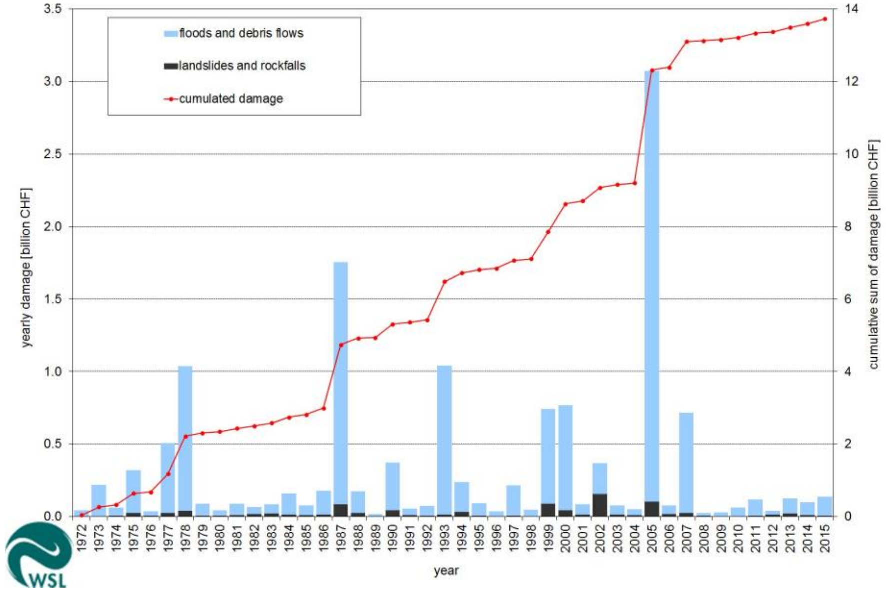
Statistics

- The Vereinigung kantonaler Feuerversicherungen (Association of Cantonal Fire Insurance Companies) provides information about the damage caused by natural forces in Switzerland in recent years. http://irv.ch/IRV/Services/Statistik/Elementar.aspx?lang=fr-CH (in German and French)

- In Switzerland storms cause damage amounting to approximately 318 million CHF every year (average for the years 1972-2014, taking inflation into account). Since 1972 the Swiss Federal Research Institute WSL has been systematically collecting (based on newspapers) and analysed this damage on behalf of the Federal Office for the Environment FOEN. Damage originating from naturally triggered floods, debris flows, landslides and (since 2002) rockfalls have been considered. Not considered was damage from avalanches, snow pressure, earthquake, lightening, hail, windstorm and drought. The corresponding weather conditions were also noted in the database. In this way, a database with currently more than 19'000 entries has been generated. http://www.wsl.ch/fe/gebirgshydrologie/HEX/projekte/schadendatenbank/index_EN

- Statistics on global natural catastrophes and manmade disaster - The reinsurer Swiss Re publishes an annual report containing statistics on the natural catastrophes and manmade disasters that occurred in the course of the previous year. http://www.swissre.com/sigma/

Swiss flood and landslide damage database



- The Figure shows that all events since 1972 have caused damage amounting to almost 13,7 billion CHF (taking inflation into account) in total. These costs are dominated by a few major events. The event of the 21th/22th of August 2005, with damage amounting to nearly 3,000 million CHF in total, was the most costly flood in Switzerland since 1972.
- The spatial distribution of the damage from 1972 to 2015 and during some large events can be viewed on an interactive map.
- The database can be analysed in terms of location, extent, causes and the temporal and spatial distribution of the storm events. The results are published yearly in the Journal "Wasser Energie Luft".
- The damage data are provided to official institutions on request as a broad information basis for hazard assessment.

http://www.wsl.ch/fe/gebirgshydrologie/HEX/projekte/schadendatenbank/index_EN

Nat. Hazards Earth Syst. Sci., 9, 913–925, 2009
www.nat-hazards-earth-syst-sci.net/9/913/2009/

Natural Hazards and Earth System Sciences

The Swiss flood and landslide damage database 1972–2007

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Abstract. In Switzerland, floods, debris flows, landslides and rockfalls cause damage every year affecting property values, infrastructure, forestry and agriculture. As population and settled areas have increased, the damage potential has also become greater. Information about natural hazard events that caused any damage is needed for hazard mapping and further decision making. This is why the Swiss Federal Research Institute WSL has been systematically collecting information on flood and mass movement damage in a database since 1972. The estimated direct financial damage as well as fatalities and injured people have been documented using press articles as the main source of information. The database can provide answers to questions related to the temporal and spatial distribution of damage, natural hazard processes and the corresponding weather conditions. This study describes the data collection methods used and the key analyses of data from 1972 to 2007. Furthermore, the benefits and drawbacks of the database are discussed. In Switzerland, naturally triggered floods, debris flows, landslides and rockfalls have caused financial damage amounting to nearly 8000 million Euros in total within the last 36 years (taking inflation into account). These processes have mainly affected pre– and central alpine regions and their total costs of damage are dominated by a few major events. Nearly one quarter of the costs result from August 2005 when large parts of Northern Switzerland were affected by flooding. We must assume that major events like this are not unique and that similar events will occur again in future.

1 Introduction

Each year, natural hazard events such as floods and landslides cause considerable financial damage to society. In Europe there have been several major events in the last few years. Floods in the catchment areas of the Elbe and the Danube in August 2002 resulted in 38 fatalities and financial damage amounting to more than 18 000 million Euros (estimate up to the end of 2002). For Germany, this event represented the most costly natural catastrophe in history (approximately 11 600 million Euros in total or 140 Euros per capita). Major damage was also registered in Austria, the Czech Republic and Slovakia (Destatis, 2008; Munich Re Group, 2003; Petrow et al., 2006; Thieken et al., 2006). In August 2005, large parts of Switzerland were flooded or affected by landslides and debris flows. Besides six casualties, an estimated financial loss of 1870 million Euros (or 250 Euros per capita) was recorded. The event was identified as the most costly for the country in at least the past 100 years (FSO and FOEN, 2008; Hilker et al., 2007). In summer 2007, parts of Great Britain were affected by extreme rainfall causing unprecedented hydrological conditions in the country's recent history at this time of year. Fourteen fatalities were due to three flood events, which occurred in June and July and the financial damage amounted to about 8000 million US $ (corresponding to more than 5400 million Euros or 90 Euros per capita with the exchange rate on 31 December 2007) (Marsh and Hannaford, 2007; Munich Re Group, 2008; UK Statistics Authority, 2008).

Such severe events in recent years are clear evidence of the kind of impact natural hazards can have on society. As in many other countries, the population and extent of settled areas have increased in Switzerland over the last few decades (FSO and FOEN, 2008). Hence, the potential for damage has also become greater. On the other hand, numerous protection measures prevent at least smaller events from having too large an impact.

It is not only insurance companies that have an interest in records of natural hazard events. Local authorities in Switzerland also need such information to complete the mapping of natural hazards. This has involved a great deal of work at the request of the federal administration and is still in progress in some regions and already completed in others. To evaluate protection requirements and to plan for land use, it is necessary to know as much as possible about natural hazard processes and their impact (FOWG, 2001). Here

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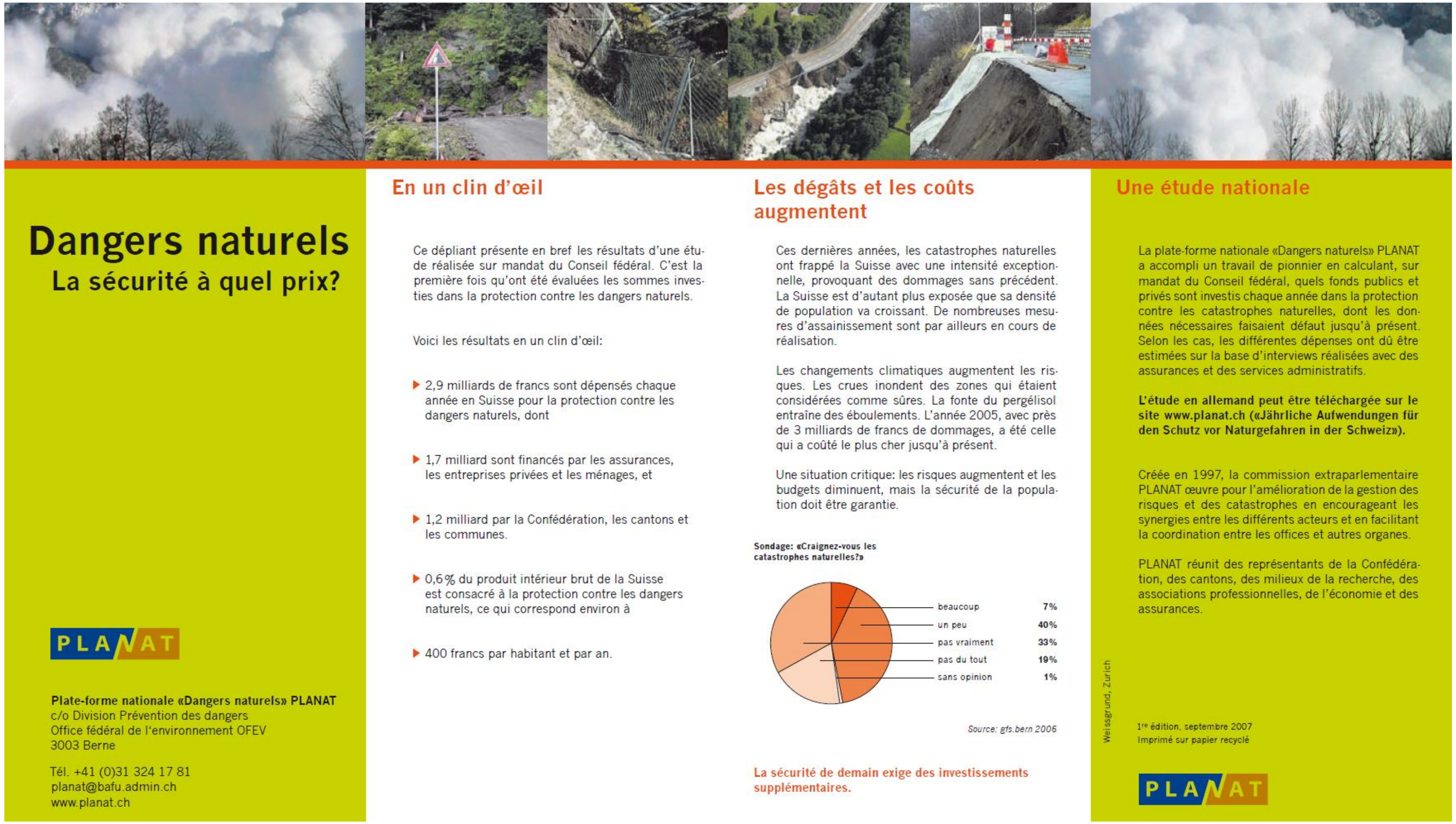
Hilker, N., Badoux, A., Hegg, C. (2009): The Swiss flood and landslide damage database 1972-2007. Nat. Hazards Earth Syst. Sci. 9: 913-925.

http://www.wsl.ch/fe/gebirgshydrologie/HEX/projekte/schadendatenbank/download/nhess-9-913-2009_lq.pdf

Natural hazards – what does security costs?



Dangers naturels
La sécurité à quel prix?

PLANAT

Plate-forme nationale «Dangers naturels» PLANAT
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Office fédéral de l'environnement OFEV
3003 Berne

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www.planat.ch

En un clin d'œil

Ce dépliant présente en bref les résultats d'une étude réalisée sur mandat du Conseil fédéral. C'est la première fois qu'ont été évaluées les sommes investies dans la protection contre les dangers naturels.

Voici les résultats en un clin d'œil:

- 2,9 milliards de francs sont dépensés chaque année en Suisse pour la protection contre les dangers naturels, dont
- 1,7 milliard sont financés par les assurances, les entreprises privées et les ménages, et
- 1,2 milliard par la Confédération, les cantons et les communes.
- 0,6 % du produit intérieur brut de la Suisse est consacré à la protection contre les dangers naturels, ce qui correspond environ à
- 400 francs par habitant et par an.

Les dégâts et les coûts augmentent

Ces dernières années, les catastrophes naturelles ont frappé la Suisse avec une intensité exceptionnelle, provoquant des dommages sans précédent. La Suisse est d'autant plus exposée que sa densité de population va croissant. De nombreuses mesures d'assainissement sont par ailleurs en cours de réalisation.

Les changements climatiques augmentent les risques. Les crues inondent des zones qui étaient considérées comme sûres. La fonte du pergélisol entraîne des éboulements. L'année 2005, avec près de 3 milliards de francs de dommages, a été celle qui a coûté le plus cher jusqu'à présent.

Une situation critique: les risques augmentent et les budgets diminuent, mais la sécurité de la population doit être garantie.

Sondage: «Craignez-vous les catastrophes naturelles?»

beaucoup	7%
un peu	40%
pas vraiment	33%
pas du tout	19%
sans opinion	1%

Source: gfs.bern 2006

La sécurité de demain exige des investissements supplémentaires.

Une étude nationale

La plate-forme nationale «Dangers naturels» PLANAT a accompli un travail de pionnier en calculant, sur mandat du Conseil fédéral, quels fonds publics et privés sont investis chaque année dans la protection contre les catastrophes naturelles, dont les données nécessaires faisaient défaut jusqu'à présent. Selon les cas, les différentes dépenses ont dû être estimées sur la base d'interviews réalisées avec des assurances et des services administratifs.

L'étude en allemand peut être téléchargée sur le site www.planat.ch («Jährliche Aufwendungen für den Schutz vor Naturgefahren in der Schweiz»).

Créée en 1997, la commission extraparlementaire PLANAT œuvre pour l'amélioration de la gestion des risques et des catastrophes en encourageant les synergies entre les différents acteurs et en facilitant la coordination entre les offices et autres organes.

PLANAT réunit des représentants de la Confédération, des cantons, des milieux de la recherche, des associations professionnelles, de l'économie et des assurances.

Weissgrund, Zurich

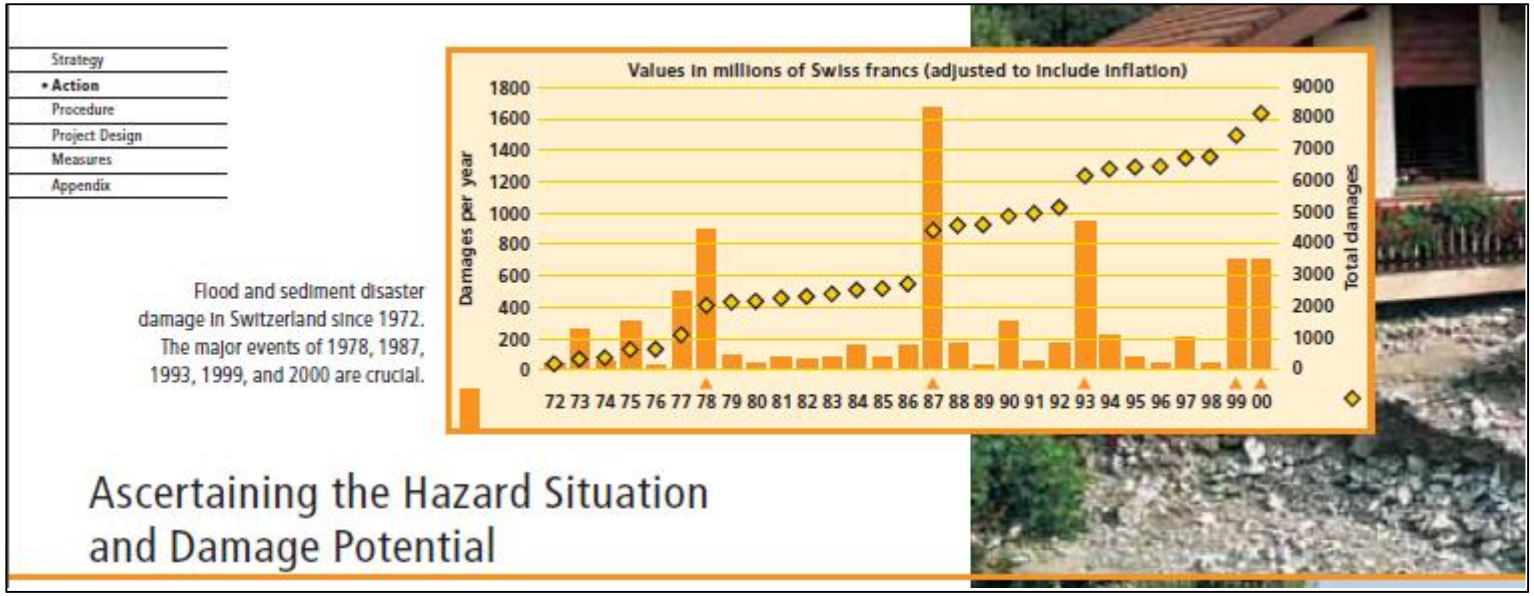
1re édition, septembre 2007
Imprimé sur papier recyclé

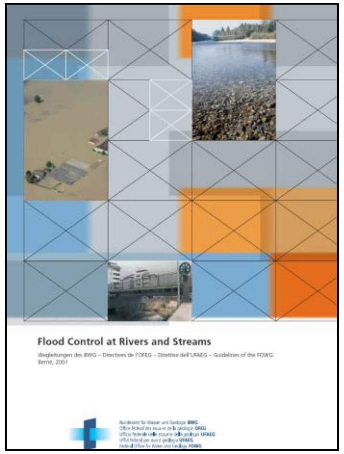
PLANAT

http://www.planat.ch/fileadmin/PLANAT/planat_pdf/alle_2012/2006-2010/PLANAT_2007_-_Dangers_naturels.pdf

http://www.planat.ch/fileadmin/PLANAT/planat_pdf/alle_2012/2006-2010/PLANAT_2007_-_Naturgefahren.pdf

Flood Control at rivers and streams





- http://www.bafu.admin.ch/publikationen/publikation/00804/index.html?lang=en
- p.14, p.16, p.44

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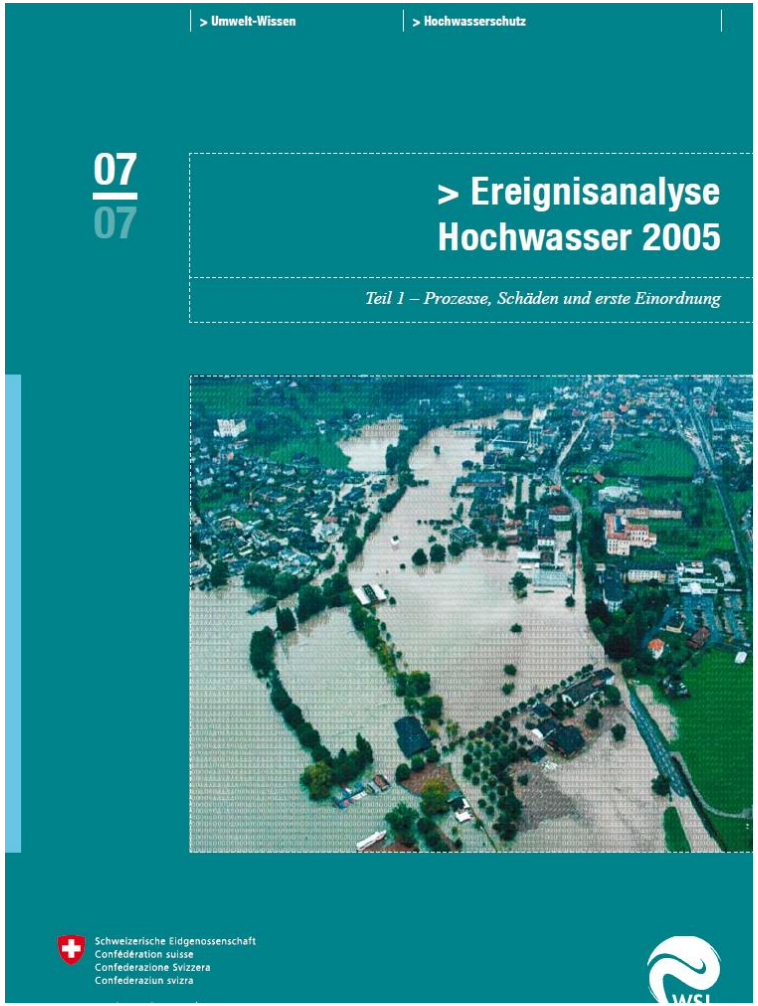
Detailed report about flooding 2005 (only in German)



At almost CHF 3 billion, the floods of August 2005 gave rise to the most extensive total financial losses ever caused by a single natural event in recent decades in Switzerland. Unfortunately the material destruction was not the end of the story. Six people also lost their lives in the floods and landslides.

The floods of August 2005 mainly caused damage to private structures and material assets. As a result, individuals and companies, or their insurance companies, bore the main burden of the damage. At around CHF 2 billion, the cost of the damage to private property was three to four times greater than that caused by all other flood events since 1972. The other damage totalled around CHF 1 billion and affected public infrastructures (hydraulic structures, roads, conduits) and railways.

http://www.bafu.admin.ch/publikationen/publikation/00044/index.html?lang=de

Expert Opinion

- Using short questionnaire
- Includes introduction to explain the context
- Key question shown here
  - Can be re-phrased depending on whether a high accuracy DTM is available, either locally or not at all.
- Can be either posted online or used to guide an interview

Q2 Had a more accurate 3D geographical information from which to produce a more accurate hydraulic flood prediction model, been available, by what percentage would the value of losses in a recent serious flood event have been reduced?

a. Details of the Flood Event you are Assessing

Catchment or Location Name ______________________________

Date ______________________________

Please now provide an upper and lower bound estimate for the following effects:

b. Better prediction (and consequent) counter-measures allowing for instance more effective evacuation.

0%	-2%	-4%	-6 %	-8%	-10%	-12%	-14%	-16%	-18%	-20%

c. Reduced Damage to property

0%	-2%	-4%	-6 %	-8%	-10%	-12%	-14%	-16%	-18%	-20%

d. Reduction in loss of production (retail, industrial and agricultural)

0%	-2%	-4%	-6 %	-8%	-10%	-12%	-14%	-16%	-18%	-20%

e. Reduction on other indirect losses (e.g. negative effects upon public services, post-traumatic stress)

0%	-2%	-4%	-6 %	-8%	-10%	-12%	-14%	-16%	-18%	-20%

Expert Opinion on Questionnaire

Flood Management
Questionnaire

1 Background

Euro SDR has commissioned research to assess the socio-economic value of high accuracy National 3D digital elevation data. In this questionnaire, we are focusing on the value of such data for mitigation of flood damage. We are requesting your assistance as an expert in this field. All results will be anonymised for the report.

2 Questions

Q1 Name: ______________________

Organisation: ______________________

Email Address: ______________________

Q2. Expert Advice

Consider the scenario in which a highly accurate 3D digital terrain model (DTM) to underpin flood prediction had not been available during the period from 2011-5 (last 5 years full years).

Assume you have all other resources necessary to respond, people, equipment and systems and effective means of communication with citizens and other public services.

Please provide an upper and lower bound estimate of the increase to damage in the following circumstances (indicated by crosses to indicate the range):

Scenario 1: No elevation model available

0%	+20%	+40%	+ 60%	+ 80%	+100%	+120%	+140%	+160%	+180%	+200%

Scenario 2. Low accuracy model (Horizontal grid 1m, Vertical accuracy +/- 1m)

0%	+20%	+40%	+ 60%	+ 80%	+100%	+120%	+140%	+160%	+180%	+200%

Q3. Please indicate any qualifications or caveats on your assessment

----

Q4. Are there enhancements to geo-information that would further reduce damage levels?

i) --
ii) --
iii) --

Thank you very much for the assistance in completing the questionnaire.

Questions

- Is the questionnaire sufficiently clear and are there modifications or other questions they might suggest?
- Who would they would suggest the questionnaire is sent to? - it seems that ideally it is distributed by them to canton or municipality level experts or through professional associations.
- How we might maximize the participation?

Feedback from two experts of the Federal Office of Environment working in the field of emergency respond and hazard prevention:

- use of official height models (swisstopo) or specially flown height models for hazard assessment and the modeling of floods (and, in general, of natural hazard processes).
- For floods the accuracy (partly also the resolution) is of great importance: The general rule is a couple of dm. The standing water (lake etc.) they need 1-2dm. This means that the data in the Questionnaire with 1m for them is completely inadequate.
- It is important to know the hazard assessment and the model applications in the individual case. In Switzerland there are three basic standards in the implementation of mass movements defined: M1 (1:25000-1:50000); M2 (1:5000-1:10000) and M3 (1:1000 or 1:2000). Please find the enforcement aid (FOEN 2016) attached as pdf (unfortunately only in German). At M3, measures are planned and detailed assessments are made. The assessment of the questionnaire is very different for M1-M3. Also for a <1m. For M2 and M3 1m is certainly not sufficient.
- How can the damage be reduced (reduce damage levels Q4)? Damage reduction for them is a completely different question. A height model does not bring any damage reduction. Damage reduction depends on the vulnerability and all the measures implemented. Hence they think, they cannot answer this question for Switzerland or regionally.

➢ we have to adapt the scale of resolution/accuracy to the reality of the people working with such data.
➢ we have an indication of the Swiss scale, but we have to find at least a European scale.
➢ And we have think deeply about questions 4, as we would like the experts to easily fill in their knowledge.

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Option 1: Cost Avoidance Results

- Costs
  - scaled from Danish budgetary costs of national LiDAR programme
- Benefits
  - Swiss loss and damage database used for example CBA – financial model supports adding your own national (or regional) information
- Expert judgement - Swiss experts declined to provide a number.
- In order to run the model therefore a conservative assessment of 1% total positive impact was assumed, this is also configurable in the model.
- Benefit-Cost Ratio 3.3 : 1
- Net present value (after 10 years) € 8.9m

Option 2:
Case Study Evidence

Public sector benefits – Dutch Water Boards

Case Study: Water board operations in Netherlands

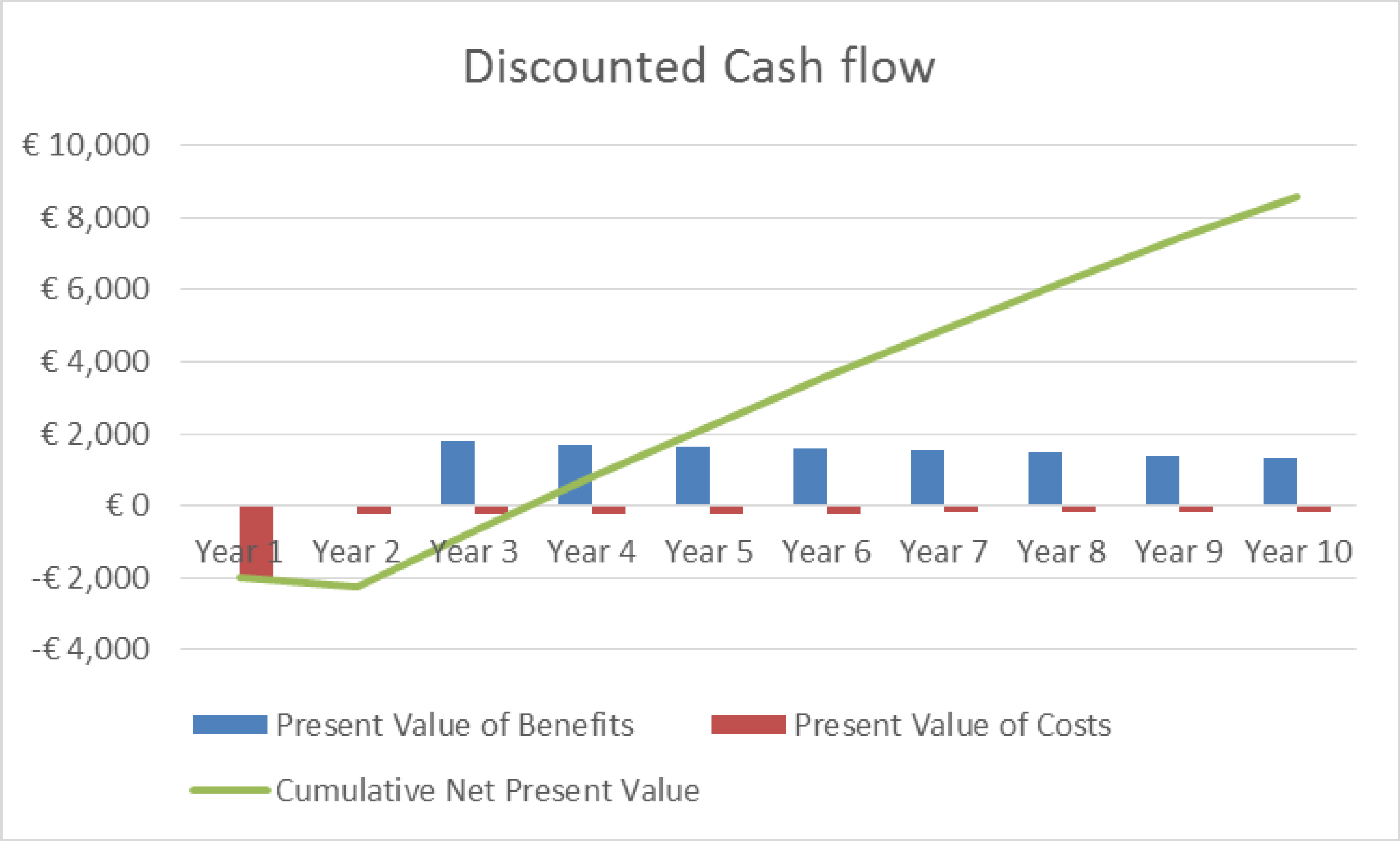
- Benefits from data sharing
  - includes external preparation of DEM specifications, contract supervision, legal costs. Based on savings a single procurement by sharing annual savings estimated at € 6.7k per annum for 6 years;
  - economies of scale: a joint project (and technical development) per hectuare price has fallen by approximately 25%;
- Reduced cost of land survey work
  - Water board spend an average of 100,000 p.a on land surveying work. Through efficient use of the AHN this can certainly save 30%. This provides an indirect saving of € 30,000 p.a.;
- Design errors for constructions detected more quickly and failure costs decrease.
- Environmental impact assessments
  - several projects can be undertaken simultaneously

- **In summary we can conclude that each province, water or regional RWS expected savings are at least around € 80,000 per year.**

Option 2: Case Studies Results

Example for Netherlands

- Benefit to Cost Ratio 3.2 : 1
- Net present value (after 10 years) € 8,597



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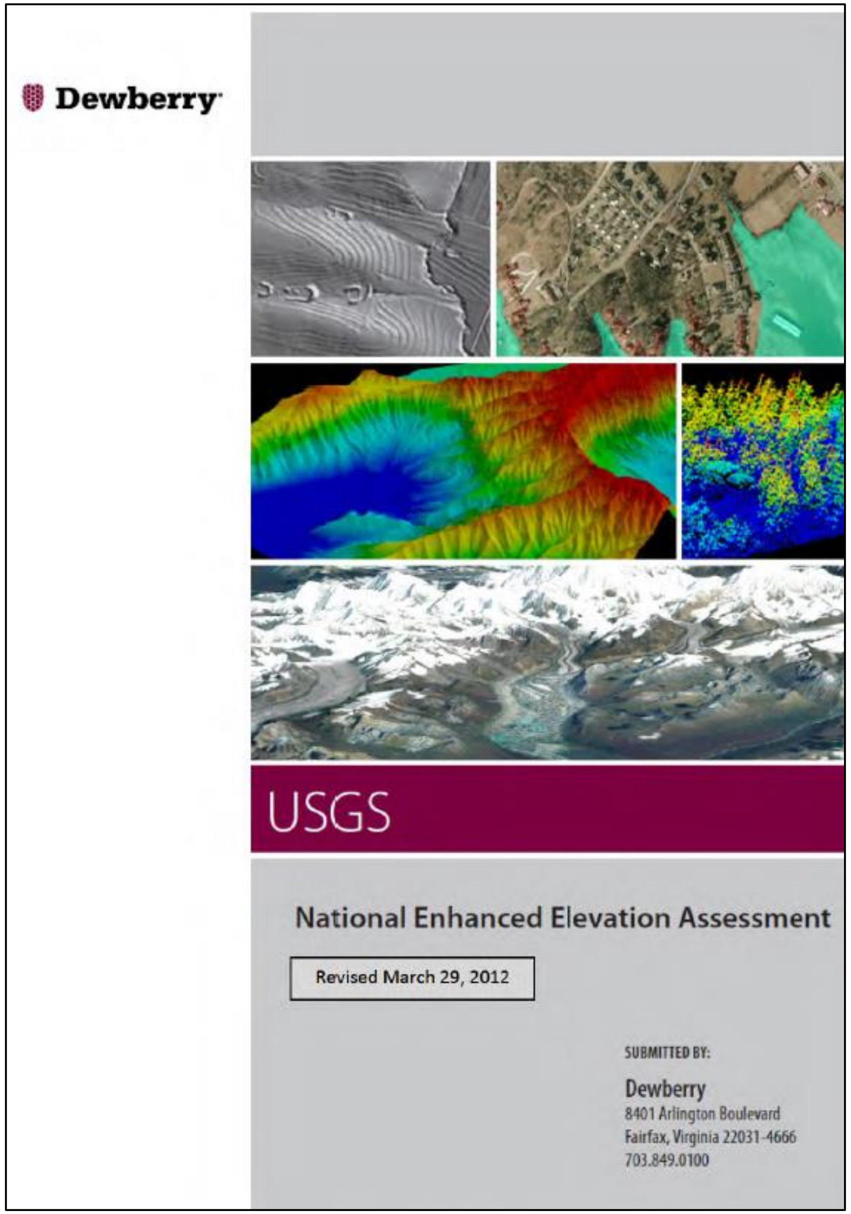
Option 3: Benefits Transfer

- Comprehensive assessment of entire US at federal, state and local level
- Assesses 27 separate Use Cases (Business uses)
- BU14 is specifically flood risk management
- The adopted scenario (2) envisages gradual capture of coterminous states (excludes Alaska) over 8 years



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Costs

- The Page to the right is from the full report (page 77)
- Table 8.4 provides the National costs
  - Only to LiDAR cost and IT Costs are included in our calculation (IFSAR is exclusively used for Alaska because of weather conditions).
- The financial model input can be changed to each of the countries involved in the project.
- Scaling is based on land area.
- Using Belgium is used as an example:

United States	8,082,000 (coterminous states)
Belgium	30,528
Factor	0.003777

- Note: For smaller countries, the economies of achievable in US may not be possible. Costs can be factored upward in the financial model to account for this.

8.3 Scenario 2 – Mixed QL1/2/3 LiDAR, 8-year Acquisition Period

As shown in Figure 8.4, under Scenario 2, QL2 LiDAR would be acquired for most of the 48 conterminous states with some QL1 LiDAR (burnt orange) and some QL3 LiDAR (yellow) cells plus QL5 IFSAR for Alaska.

The data collected under Scenario 2 is optimized to provide the highest net benefit to the federal government or best meet the greatest amount of federal government program requirements in terms of Quality Level, with no area receiving less than QL3 in the conterminous U.S. An update frequency of 8 years was chosen because the 6-10 year update frequency consistently provided the best Benefit/Cost Ratio.

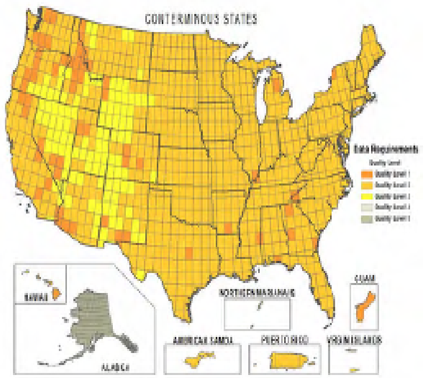

Figure 8.4. Scenario 2, mostly QL2 LiDAR nationwide with some QL1 and QL3 LiDAR; QL5 IFSAR for Alaska; 8-year acquisition period. This scenario has an optimal federal focus that benefits states and nongovernmental organizations also.

Scenario 2 would result in the following annual costs and benefits from the LiDAR and IFSAR data, excluding IT costs for data management and dissemination:

Total Annual Data Costs: $134.6M/year	Total Annual Data Benefits: $698.9M/year
Data Benefit/Cost Ratio: 5.194	Net Annual Data Benefits: $564.4M/year

Table 8.4 accumulates the annual costs and benefits over the 8-year lifecycle of Scenario 2, including IT costs for data management and dissemination. All numbers are in 2011 dollars.

Table 8.4. Scenario 2 Cumulative Lifecycle Costs and Benefits (in $ millions) over 8-year Acquisition Period

Costs and Benefits	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	8-Year Total
LiDAR Data Costs	$128	$256	$384	$512	$640	$767	$895	$1,024	$1,024M
IFSAR Data Costs	$7	$13	$20	$27	$33	$40	$47	$53	$53M
IT Costs	$20	$28	$36	$45	$64	$79	$92	$106	$106M
Combined Costs	$155	$298	$440	$583	$737	$886	$1,034	$1,183	$1,183M
Combined Benefits	$699	$1,398	$2,097	$2,796	$3,495	$4,194	$4,893	$5,591	$5,591M

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Benefits

From the report we have extracted some key examples of benefits:

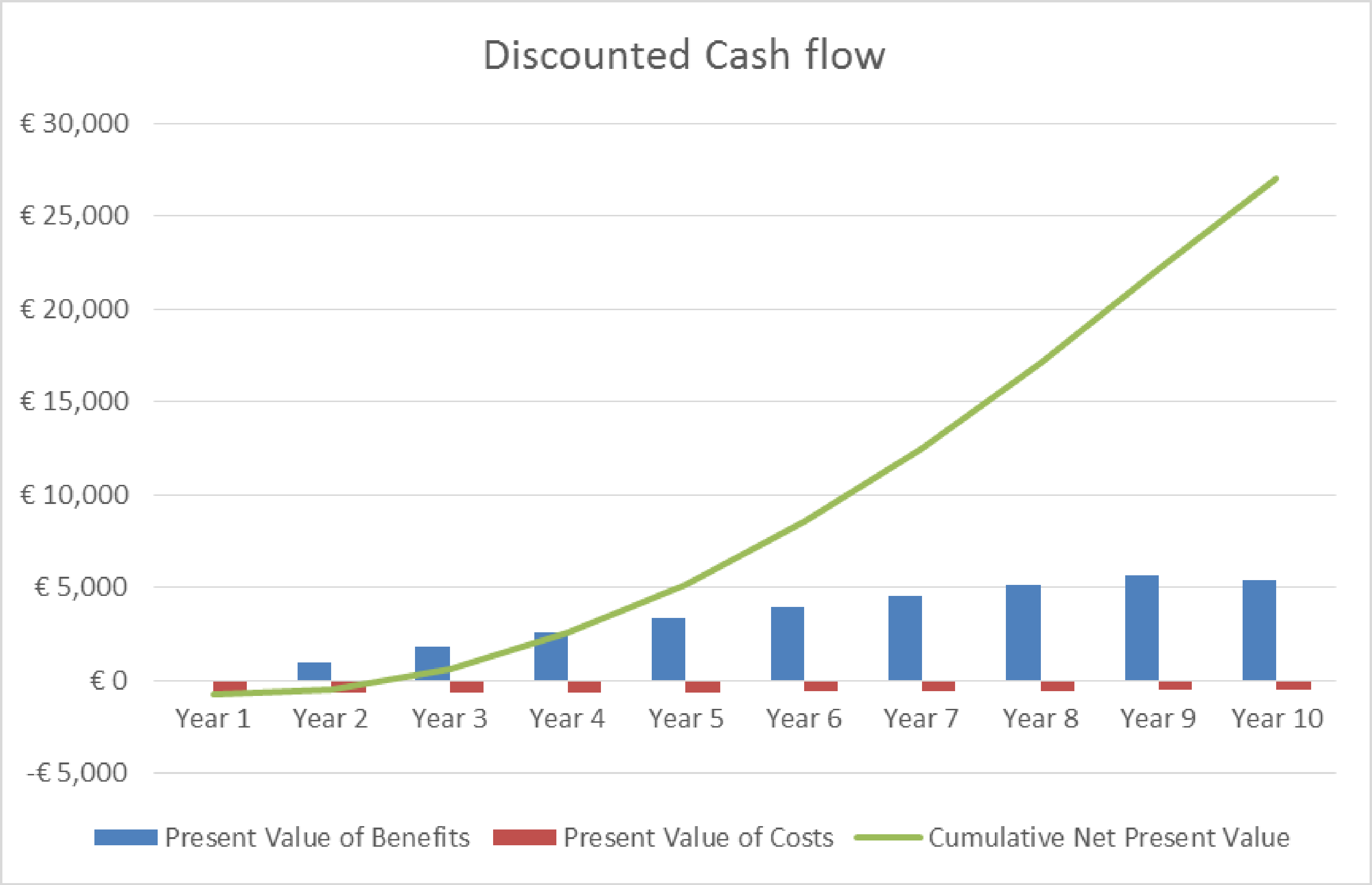
- Federal Emergency Management Flood risk Analysis - US$13.5 million p.a.
  - More accurate FIRMs thereby reducing losses of life, property and business; increasing confidence in their credibility; providing more consistent insurance ratings and better communication of flood risks; ensuring that structures are insured at appropriate levels;
- Weather Service - static Inundation mapping – US$24million p.a.
  - riverine areas for which the National Weather Service (NWS) provides Advanced Hydrologic Prediction Service (AHPS) inundation mapping as well as river and flood forecasts
- Corp of Engineers (USACE) - US$ 31 million per annum
  - manage dam and dyke safety programs, to estimate depths of flooding from predicted river flood stages, to perform breach analyses, and to make informed decisions regarding flood control systems and release of impounded waters.

Overall Potential Benefits assessed as US$ 501 million per annum

Option 3: Benefits Transfer Results

- Belgium Example (implementation over 8 years)

Benefit-Cost Ratio	5.3 : 1
Net present value (after 10 years)	€ 27m



Thank You