technische universität dortmund

IRPUD

Natural hazards and spatial planning

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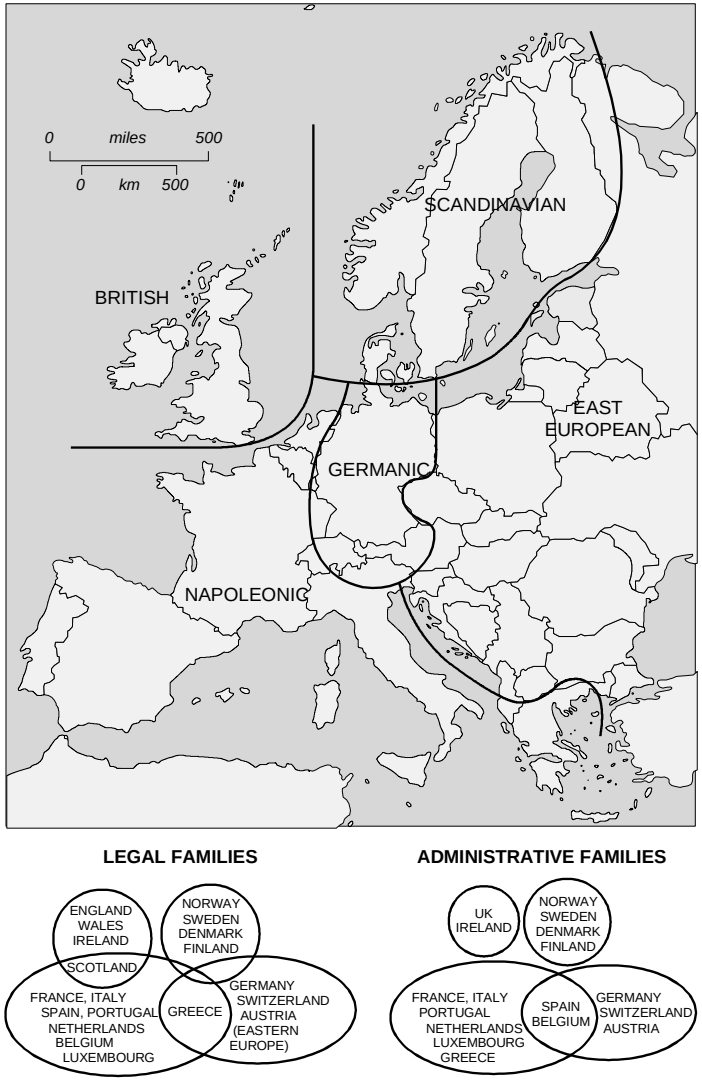
1. What is spatial planning about?
2. Spatial planning and risk
3. Disaster response by spatial planning
4. Disaster risk assessment and Impact Assessment
5. Conclusions – strength and weaknesses of spatial planning

1. What is spatial planning about?

- Spatial planning is defined as comprehensive, over-sectoral planning.
- Spatial planning bases on a set of legal frameworks and rules which differ among Europe.
- The European Union does not have any legal competence for urban planning.
- But: spatial planning and adaptation are addressed by the Territorial Agenda 2020
- Several directives point at role of spatial planning:
  - Floods directive
  - SEA directive
  - SEVESO III directive



The legal and administrative 'families' of Europe. Source: Newman & Thor

p.29

Table 1: The planning system

Spatial level	**Spatially relevant planning**				**Spatially non-relevant planning**
	Comprehensive		Sectoral (transport, water, geology, emergency response, etc.)		Forms of non-spatial management on different spatial levels
Europe	Spatial planning	European spatial development (no binding character)	Sectoral planning	Environmental Policies, TEN, CAP	e.g. budget planning
Member State		Spatial development planning		e.g. national transport network plan	e.g. defence planning, education
Sub-Member State level (federal state, region, or other spatial units)		Regional planning (partly land-use related)		e.g. river basin authorities in charge of management plans, partly land-use planning and management related	e.g. cultural development, education planning
Municipality (all planning on this level can be subsumed together under the term *"urban planning and management"*)		Local land-use planning		e. g. waste and sewage planning, public transport planning, municipalities are in charge of (land-use management)	e.g. lower education, municipal budget planning

Source: own table

- It is the definition of risk that affect risk policy and moreover, defining risk is an exercise in power in view of existing ambiguity.
- In European member states, governed according to law, the existing legal framework serves as normative basis for any risk assessment and risk management, to be taken by public as well as private bodies.
- In particular, public planning and building law, but also the several other technical codes can be seen as legal frame for concrete mitigation measures.
- The legal framework as well as the political-administrative system significantly determine how disaster responses are designed and by which institutions they are implemented.
- The specifics of the different Member States mainly characterise the design of national policies.

- In some of the EU Member States e. g., a new development is legally allowed when it is conforms to the regional/local plan.
- This so called regulatory function of spatial planning is known under the term “conforming planning” in the international discourse on planning theory (Rivolin, 2008; Larsson, 2006).
- In most of the EU Member States, the so called development function dominates at the regional planning level which is discussed under the term “performing planning”.
- This planning type is characterised by non-binding programmatic and/or strategic statements.
- Potential projects are then evaluated against the question whether they support the implementation of the programme or strategy.
- Furthermore, there are – if at all – only partially binding effects for the subordinated local level.

2. Spatial planning and risk

- Space can be defined as the area within which human beings and their artefacts may be threatened by spatially relevant hazards.
- Every hazard has a spatial dimension (it takes place somewhere).
- The decision about whether to tolerate a risk or to try to alter it can be understood as an integral part of the existing socio-economic structures and institutions.
- Spatial character of a hazard can either be defined by spatial effects that might occur if a hazard turns into a disaster, or by the possibility for an appropriate spatial planning response.
- This dual character opens up questions about the relevance of different levels of spatial planning as well as the relationship to sectoral planning.
- Spatial planning makes decisions for society about whether and how certain spaces will be used.
- Spatial planning influences the vulnerability in cases of spatially relevant natural and technological hazards.

- Spatially oriented risk management has three main characteristics:
  1. Multi-risk orientation. The nature of spatial planning requires a multi-risk approach that considers all relevant hazards that threaten a certain area as well as the vulnerability of this area.
  2. Consideration of spatially relevant hazards. Ubiquitous risks like epidemic diseases or traffic accidents are not the focus of the analysis.
  3. Only collective risks that threaten a community as a whole are relevant and not individual risks like driving in a car or smoking.
- Problem of external effects: a spatial and temporal inconsistence between chances and risks.
- Example: (intra-generational) conflict between actors living upstreams and downstreams: A municipality located upstream might profit from the chances of a suitable location for an industrial area located in the flood plains of a river and could protect this area by means of a dike. As direct consequence, the flood risk downstreams may increase.
- Risk assessment and management are an integrated part of the planning process.

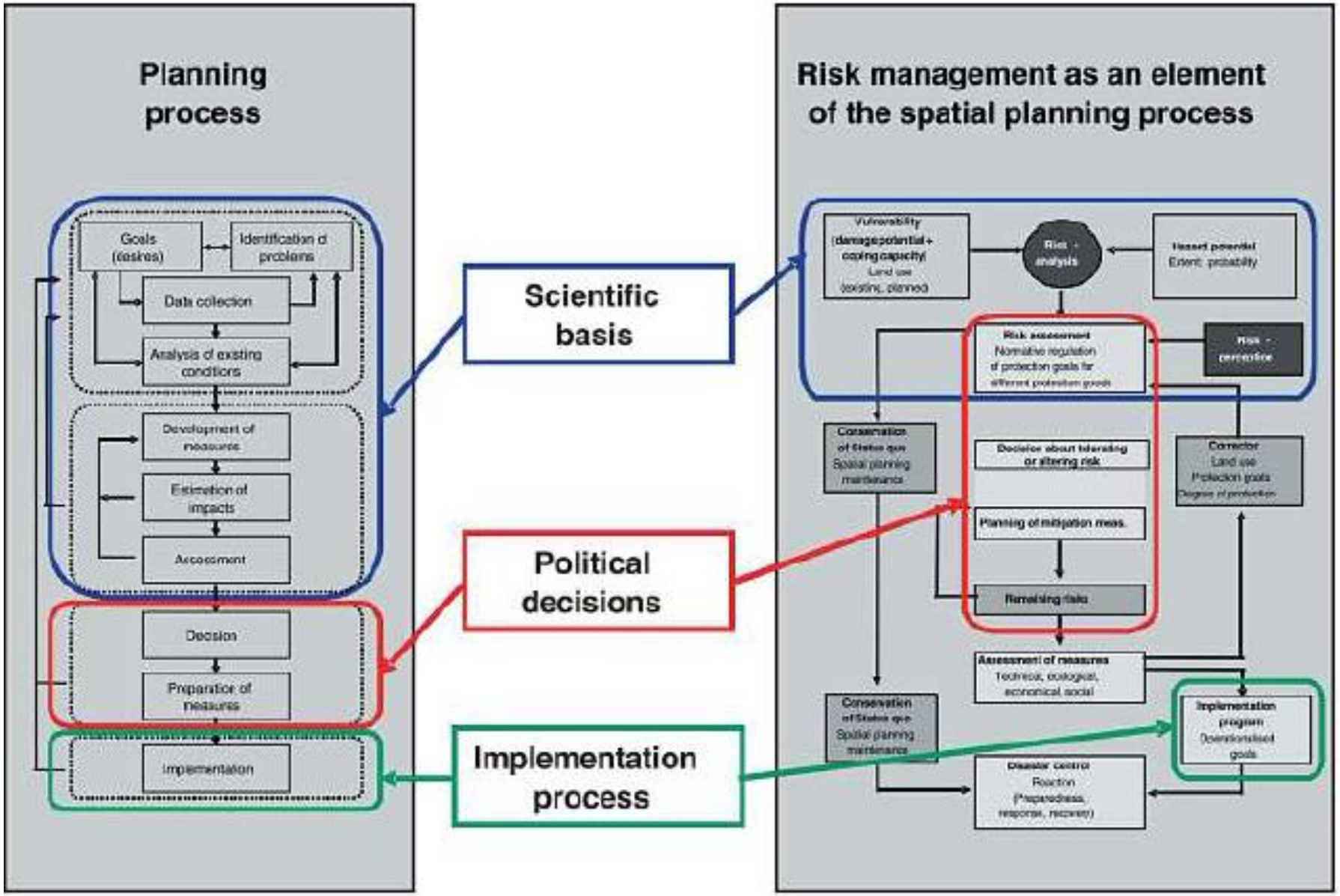


Figure 2: The procedural dimension of risk assessment and management

Source: Greiving and Fleischhauer (2006)

3. Disaster response by spatial planning

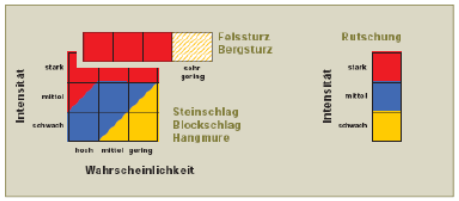
a) Keeping areas free of (further) development

- prone to hazards,
- Securing “appropriate distances between establishments and vulnerable land-uses” (Art. 13 SEVESO III Directive)
- needed to lower the effects of an hazardous event (e.g. water retention areas) and;
- needed to guarantee the effectiveness of response activities (e.g. escape lanes and gathering points).
- Aims at mitigating further vulnerabilities, but considers only the hazard
- Fails in regard to existing settlements/infrastructures at risk
- Evidence basis: i.e. hazard maps, partly differentiation into intensity/frequency classes

Discussion of different models

Model	Coordinated zoning in general land-use plan	Specific hazard map in general land-use plan with binding effects	Independent map without binding effects
Description	Consideration of the hazard prone areas during the compiling or review of the local land-use plan (informed i.e by SEA)	The hazard zones are displayed as a separate map which has a direct effect on land ownership rights	Definition of hazard zones within the scope of expert planning – objections may be raised to decisions that are made on this basis
Advantages	At the local level, no additional instruments are needed; hazards are weighted- up against other concerns and interests	The hazard can be considered in a uniform manner for the whole municipality. Definition of hazard zones can be applied directly in building approval procedures	A simple alteration of a hazard zone plan is possible. Suitable for a cooperative strategy that aims at influencing existing building structures by individual building protection
Disadvantages	Land-use plans only contain information about hazard prone areas when a specific reference is made. N alternation of the danger situation means the plan must be adapted accordingly	An alteration of the risk means that the complete zoning plan has to be adapted accordingly. For legally binding effects, a very exact evidence basis is needed	Not effective if private stakeholders do not want to follow the advise

Examples:



Die Bedeutung der Gefahrenstufen wird wie folgt erläutert (vgl. BWW/BRP/BUWAL 1997: 25):

rote Zone: erhebliche Gefährdung

Es dürfen grundsätzlich **keine Bauten und Anlagen**, die dem Aufenthalt von Mensch und Tier dienen, errichtet oder erweitert werden. Nichtüberbaute Bauzonen sollen rückgezont werden. Zerstörte Bauten dürfen nur in Ausnahmefällen – wenn sie zwingend auf diesen Standort angewiesen sind – wiederaufgebaut werden (und auch dann nur mit den entsprechenden Sicherheitsmassnahmen). Umbauten und Zweckänderungen sind nur gestattet, wenn dadurch das Risiko vermindert wird (d.h. heisst, wenn der gefährdete Personenkreis nicht erweitert und die Sicherheitsmassnahmen verbessert werden). Bei bestehenden Siedlungen sind bei gravierendem Schutzdefizit nach Möglichkeit wasserbauliche Schutzmassnahmen vorzusehen.

gelbe Zone: geringe Gefährdung

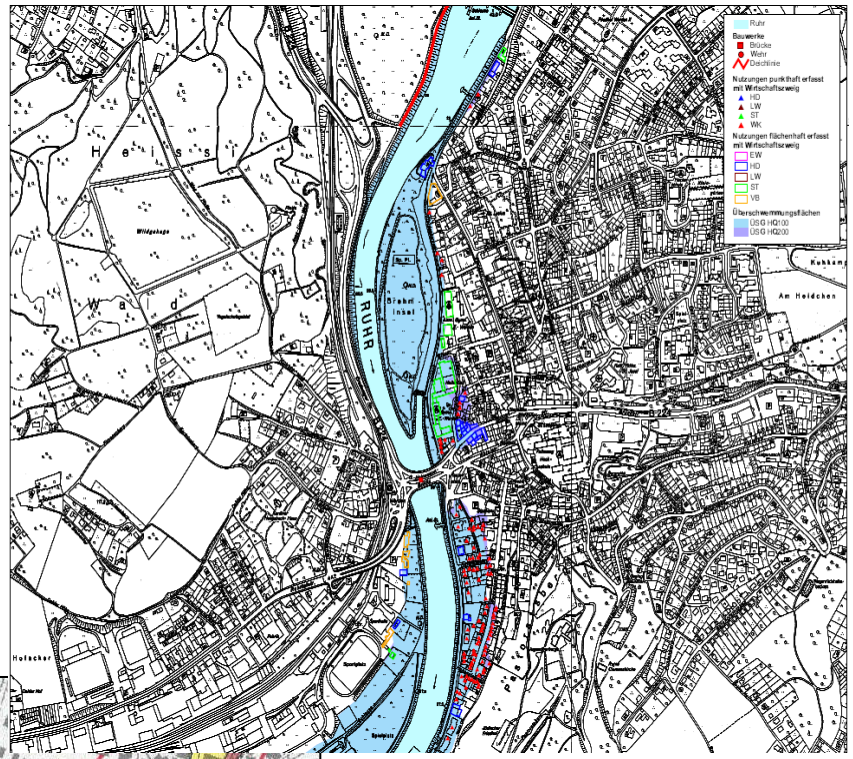
Die Grundeigentümer sind auf die **bestehende Gefährdung** und auf mögliche Massnahmen zur Schadenverhütung aufmerksam zu machen. Eine spezielle Massnahmenplanung für sensible Objekte ist notwendig.

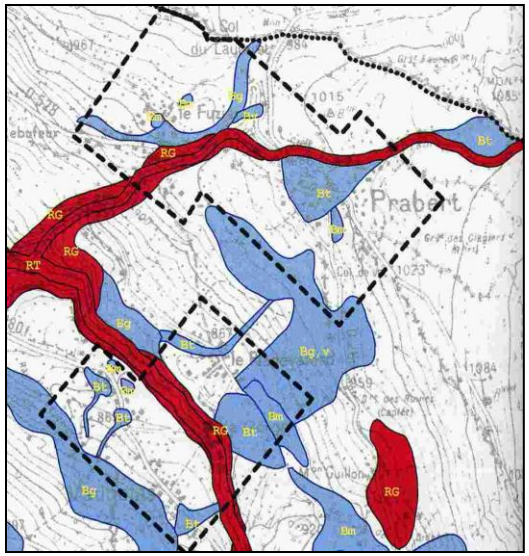
gelb-weiss gestreifte Zone

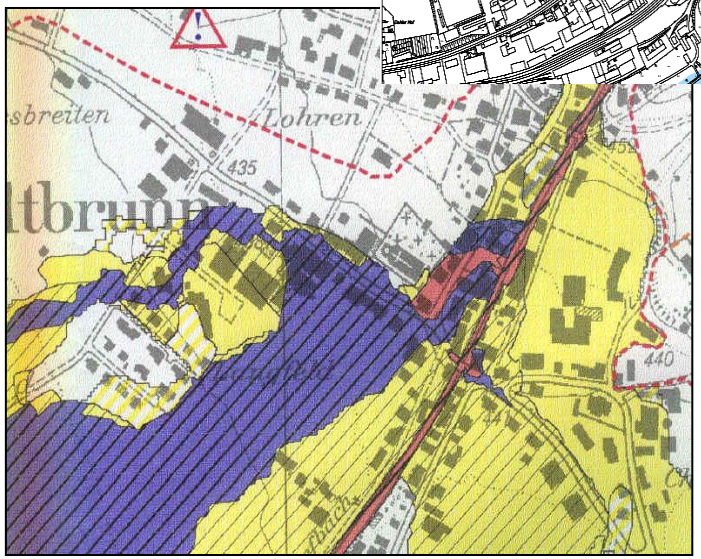
Die gelb-weiss gestreifte Zone zeigt das Restrisiko auf. Eine Notfallplanung und spezielle Massnahmen für **sensible Objekte** sind notwendig. Anlagen mit sehr hohem Schadenpotential sind zu vermeiden.

blaue Zone: mittlere Gefährdung

Bauen ist mit **Auflagen** erlaubt. Diese sollen mit einem der jeweiligen Gefahrenart entsprechendem Inhalt in Bau- und Zonenreglement festgehalten werden. Im Einzelfall können auch weitere detaillierte Abklärungen nötig sein. Es sind keine besonders sensiblen Objekte zu erstellen, und es sollen nach Möglichkeit keine neuen Bauzonen ausgeschieden werden.







Flood hazard map (Germany)

Figure 3: Risk prevention plan (integrated) for Laval/France (left); (b) Flood hazard map for a Swiss municipality (right).

b) Differentiated decisions on land-use

- Acceptable land-use types according to the given hazard/vulnerability combination
- Considers susceptibility of different land-use types
- Evidence basis: hazard and risk maps; detailed information needed about frequency/magnitude curves

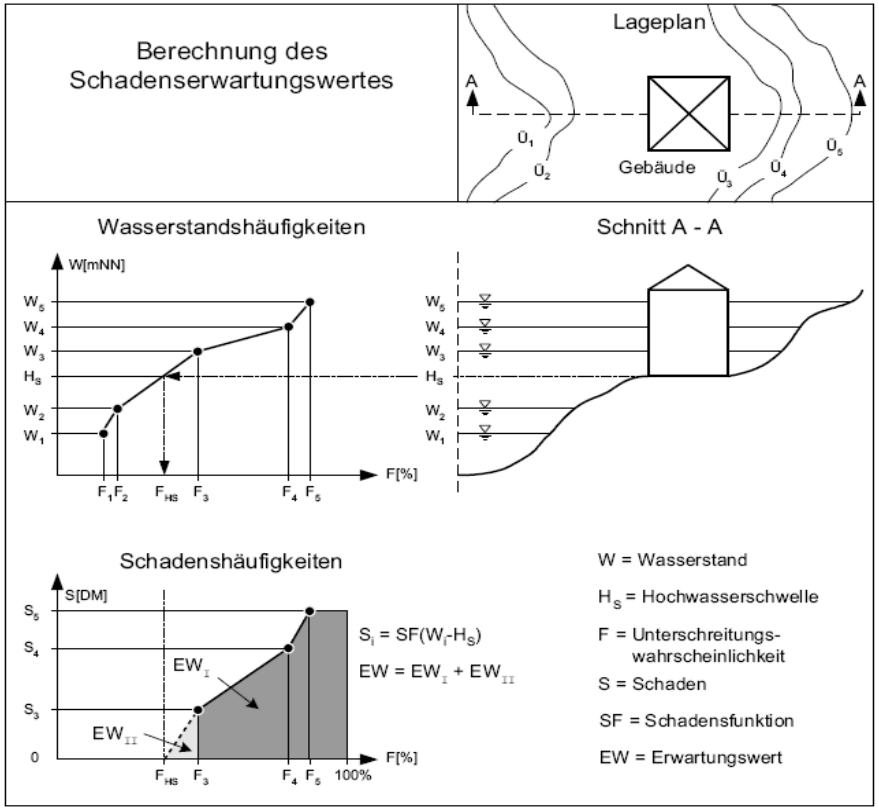
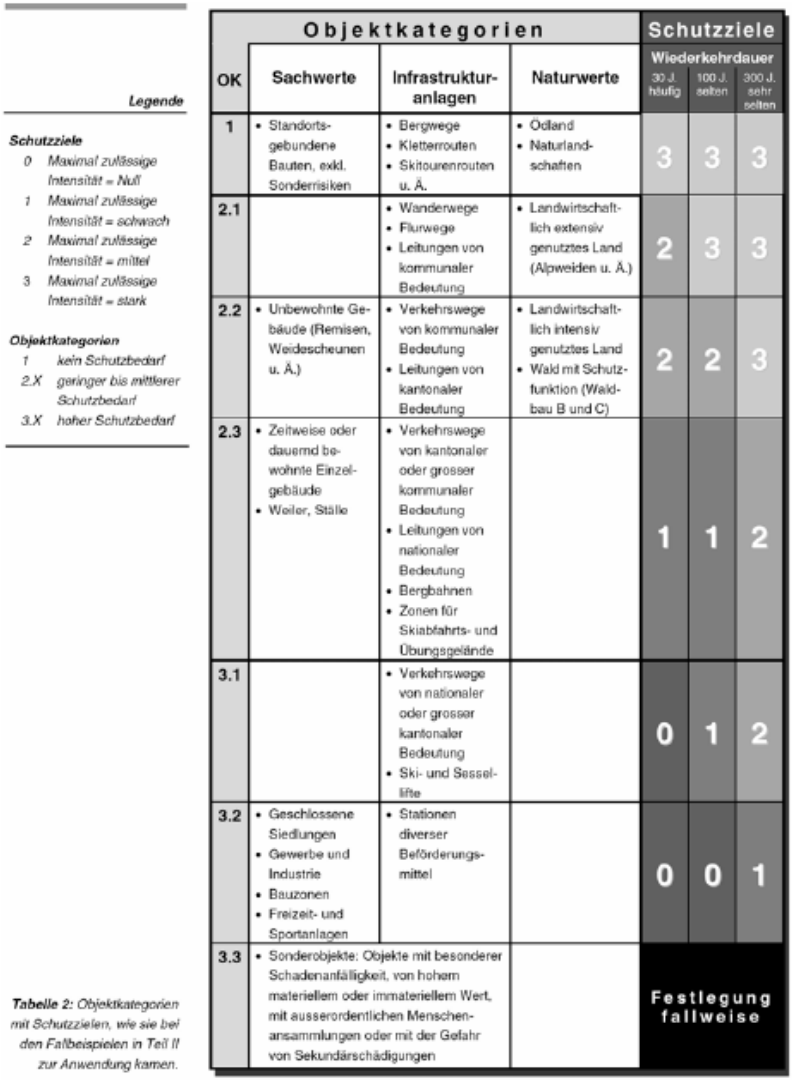


Figure 4: Damage function. Source: Bezirksregierung Köln (2008)

Example: Schutziele (Protection goals) Switzerland

- Differentiated protection goals for several protections goods (assets, infrastructure, nature)
- Definition of acceptable magnitude of event for three different return periods



Legende

Schutzziele

0 Maximal zulässige Intensität = Null
1 Maximal zulässige Intensität = schwach
2 Maximal zulässige Intensität = mittel
3 Maximal zulässige Intensität = stark

Objektkategorien

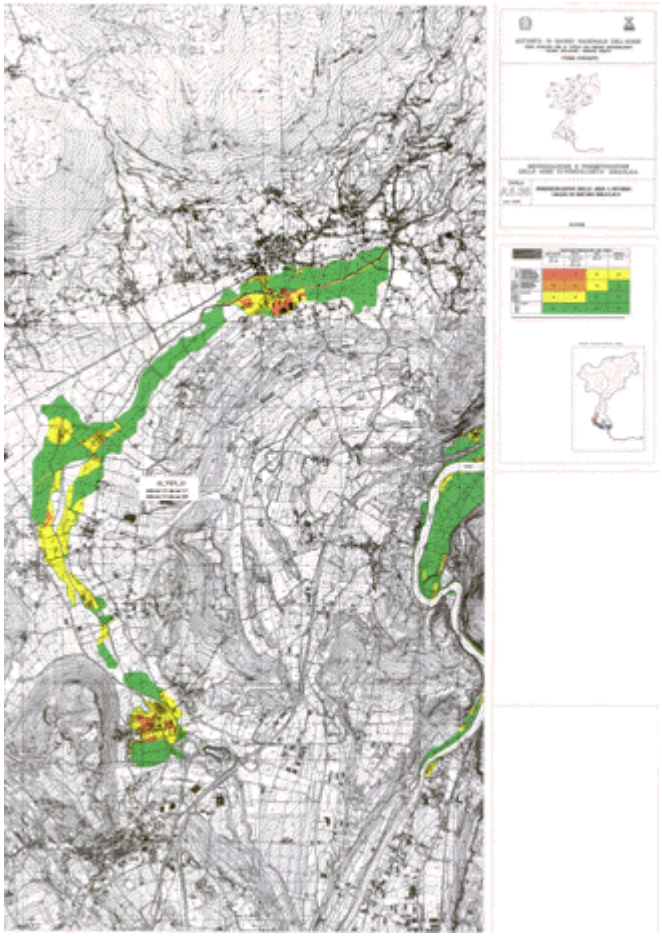
1 kein Schutzbedarf
2.X geringer bis mittlerer Schutzbedarf
3.X hoher Schutzbedarf

Objektkategorien				Schutzziele		
				Wiederkehrdauer		
OK	Sachwerte	Infrastruktur-anlagen	Naturwerte	30 J. häufig	100 J. selten	300 J. sehr selten
1	• Standorts-gebundene Bauten, exkl. Sonderrisiken	• Bergwege • Kletterrouten • Skitourenrouten u. Ä.	• Ödland • Naturland-schaften	3	3	3
2.1		• Wanderwege • Flurwege • Leitungen von kommunaler Bedeutung	• Landwirtschaft-lich extensiv genutztes Land (Alpweiden u. Ä.)	2	3	3
2.2	• Unbewohnte Ge-bäude (Remisen, Weidescheunen u. Ä.)	• Verkehrswege von kommunaler Bedeutung • Leitungen von kantonaler Bedeutung	• Landwirtschaft-lich intensiv genutztes Land • Wald mit Schutz-funktion (Wald-bau B und C)	2	2	3
2.3	• Zeitweise oder dauernd be-wohnte Einzel-gebäude • Weiler, Ställe	• Verkehrswege von kantonaler oder grosser kommunaler Bedeutung • Leitungen von nationaler Bedeutung • Bergbahnen • Zonen für Skiabfahrts- und Übungsgelände		1	1	2
3.1		• Verkehrswege von nationaler oder grosser kantonaler Bedeutung • Ski- und Sessel-lifte		0	1	2
3.2	• Geschlossene Siedlungen • Gewerbe und Industrie • Bauzonen • Freizeit- und Sportanlagen	• Stationen diverser Beförderungs-mittel		0	0	1
3.3	• Sonderobjekte: Objekte mit besonderer Schadenanfälligkeit, von hohem materiellem oder immateriellem Wert, mit ausserordentlichen Menschen-ansammlungen oder mit der Gefahr von Sekundärschädigungen			Festlegung fallweise		

Tabelle 2: *Objektkategorien mit Schutzzielen, wie sie bei den Fallbeispielen in Teil II zur Anwendung kamen.*

Figure 5: Swiss protection goals. Source: BUWAL 1999

Example: Italinan „piano stralcio per la tutela dal rischio idrogeologico“ (hydrogeological risk map):



RISK ASSESSMENT			Hydraulic Hazard [$Q_{Tr=30\ years}$ - $Q_{Tr=100\ years}$ - $Q_{Tr=200\ years}$]			
			VERY HIGH	HIGH	MEDIUM	MODERATE
			$h_{Tr=30} > 1$ m $V_{Tr=30} > 1$ m/s	1m> $h_{Tr=30}$ > 0.5m $h_{Tr=100} > 1$ m $V_{Tr=100} > 1$ m/s	$h_{Tr=100} > 0$ m	$h_{Tr=200} > 0$ m
RISK (EXPECTED DAMAGES)	EXTREME	Residential settlements, industrial plants, main roads, railways, life lines, public equipments, areas for future urban growth	R4	R4	R2	R2
	MEDIUM	Areas bound for their environmental or landscape value, areas of public interest (sport and recreational areas, parking areas, …)	R3	R3	R2	R1
	MODERATE	Agricultural areas (Vineyards and Orchards)	R2	R2	R1	R1
	LOW	Agricultural areas	R1	R1	R1	R1

Figure 6: Hydrogeological risk map, risk index, Arno river basin. Source: Mentoni and Galderisi (2006)

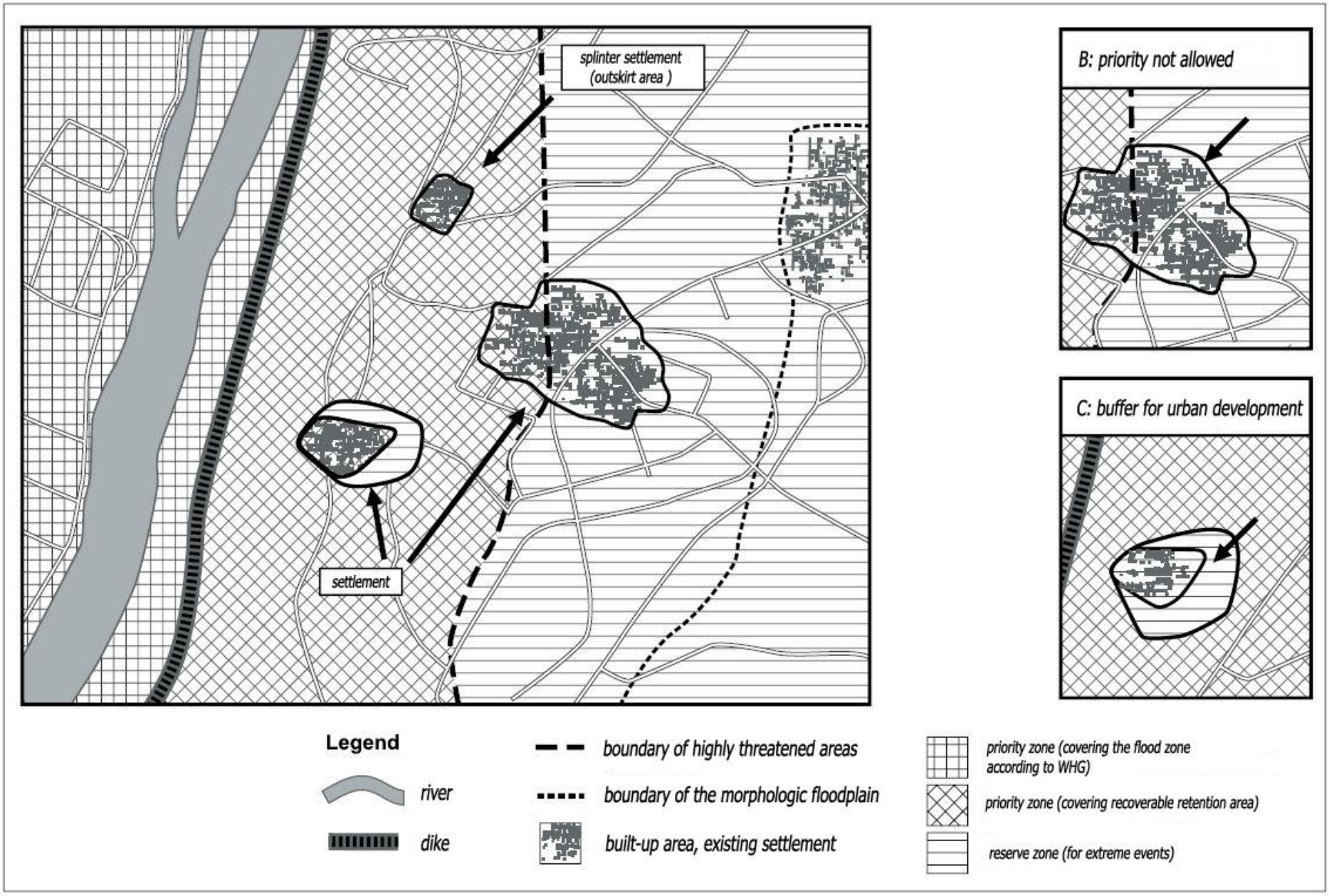


Figure 7: Priority zones and reserve zones for flood prevention in Germany. Source: own figure

c) Adaptation of building structures

- Aims at mitigating susceptibility of those land-uses which are principally permissible in hazard prone areas.
- In accordance with given planning law either possible by designations in legally-binding land-use plans and/or specific requirements as part of a building permission
- Options:
  - Flood prone areas: minimum elevation height, complete prohibition of basements or avoidance of damage potential (living/sleeping rooms, electric facilities etc.)
  - Earthquake prone areas: specific requirements for statics of the building
  - Landslide prone areas: specific requirements for the groundwork of the building

Figure 8: Guidebook on Building Protetion: Source: BMVBS (2010)

d) Mitigating the hazard

- Aims at lowering the hazardous effects (frequency and or magnitude) by suitable designations in land-use plans
- Not possible for all hazard types (e. g. volcanoes or earthquakes)
- Options:
  - Flooding: extension of retention areas
  - Avalanches/landslides: extension of protective forest

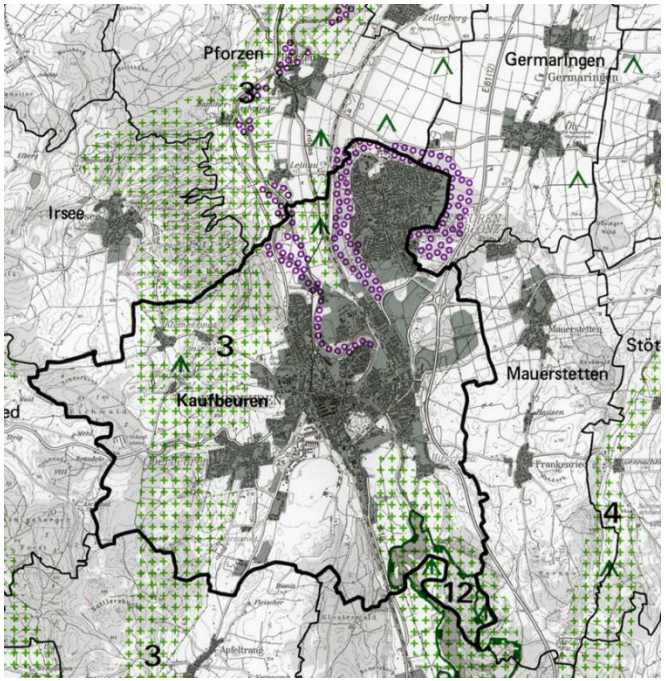
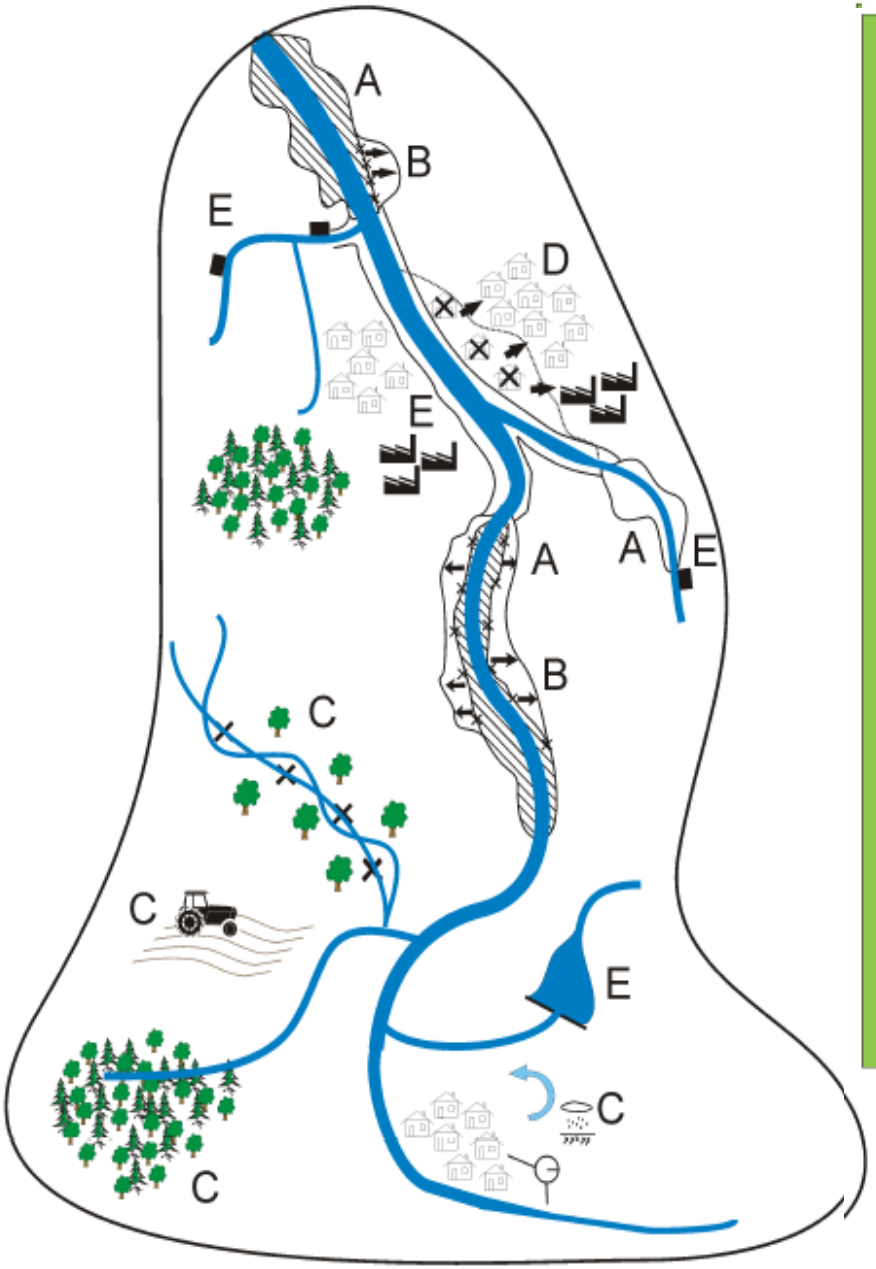


Figure 9: Protective forest (in violet). Source: Regionaler Planungsverband Allgäu (2007)



A Protection of existing retention areas
Keeping clear of non-tolerable use of
- flood plains
- meadow land
- existing detention ponds

B Extension of retention areas
- backward relocation of dikes
- creating detention ponds
- restoration of large streams
- floodplain scrapes/deepening of retention areas
-

C Retention in the catchment
- rainwater storage and greywater use
- restriction of sealed surfaces
- reduction of interflow on agricultural and forestry land
- restoration of small streams

D Minimisation of damage potential
- preventive land use management
- precautionary measures of construction
- information of the public
- improvement of public awareness
- prediction and warning of floods
- disaster prevention/control

E Technical flood protection measures
- dikes
- flood protection walls
- retention ponds
- river dams, barrages

Focuses of spatial planning

Figure 10: Fields of action of flood risk mitigation by spatial planning. Source: own figure

e) Retreat from hazard prone areas

- Aims at reducing or avoidance of vulnerability
- Related to existing structures at (high) risk where other mitigation measures fail
- May become necessary due to climate change (i.e. sea level rise)
- Controversial due to several reasons:
  - Extremely costy (full compensation needed due to private property rights
  - Causes often (violent) protests of land owner (expropriation needed) because of relatedness of population which may stay for centuries at a plot of land
- Window of opportunity in the aftermath of a disaster

- 1st phase: The society just resists the damages (“resistance”.)
- 2nd phase: Over time and with rising sea level, it becomes efficient to protect areas with certain measures (“resilience”)
- 3rd phase: Further protection measures are not efficient any more at all (“retreat”).
- Scenarios could be the justification for the change of “efficiency curves”.
- Climate Change will influence the function.
- In consequence the turning point moves to the left: resilience and retreat becomes more efficient – even before a disaster strikes.

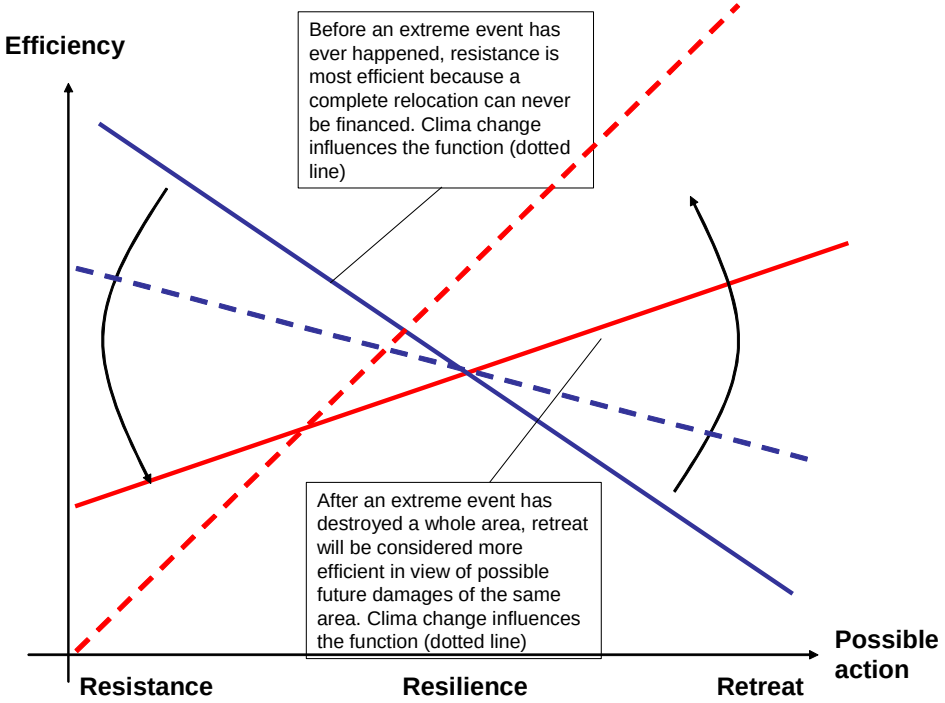


Figure 11: Change of efficiency of actions/measures in dependence of disaster occurrence. Source: Schmidt-Thomé and Greiving (2008)

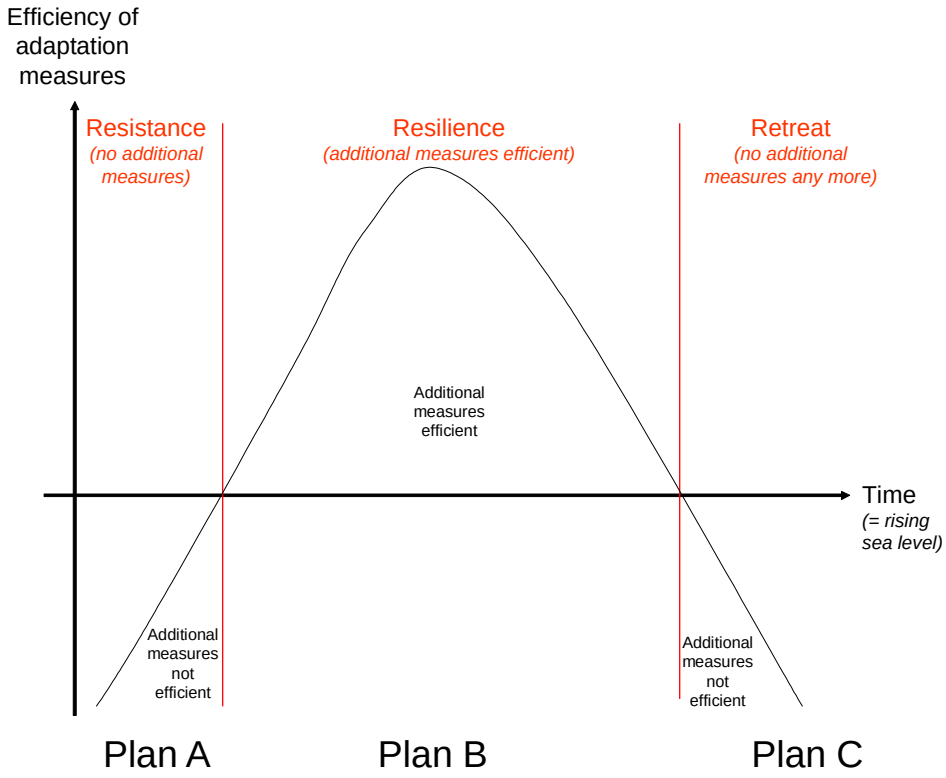
1st phase: “Plan A” (means no plan necessary that considers hazards and vulnerability).

2nd phase: “Plan B”: Thinking of a new design of spatial structures: relocate (highly vulnerable land-uses) and adapt protection (e. g. uplifted structures for those land-use which are still beneficial in threatened areas).

In this way, a society would be better prepared for the recovery phase after a disaster, understood as a “window of opportunity”

Phase of retreat: Leave the area completely after other measures are not efficient any more (“Plan C”).

Of course, highly controversial



Threshold points

Might be influenced by vulnerability reduction

Figure 12: Change of efficiency of adaptation measures over time (rising sea level). Source: Schmidt-Thomé and Greiving (2008)

Example: Riesa-Röderau in Saxony

- 139 building - which had been built 3-5 years before - were deconstructed after the 2002 Elbe flood event.
- € 40 Mio. were spent for compensations.
- This single case was only possible due to enormous political efforts on the federal state level.
- The lack of financial capacities as well as political willingness makes clear that retreat as a catchment-wide mitigation strategy must fail – at least with respect to existing structures.

Figure 13: Riese-Röderau during the flood (above) and at the final stage of the deconstruction process (below)

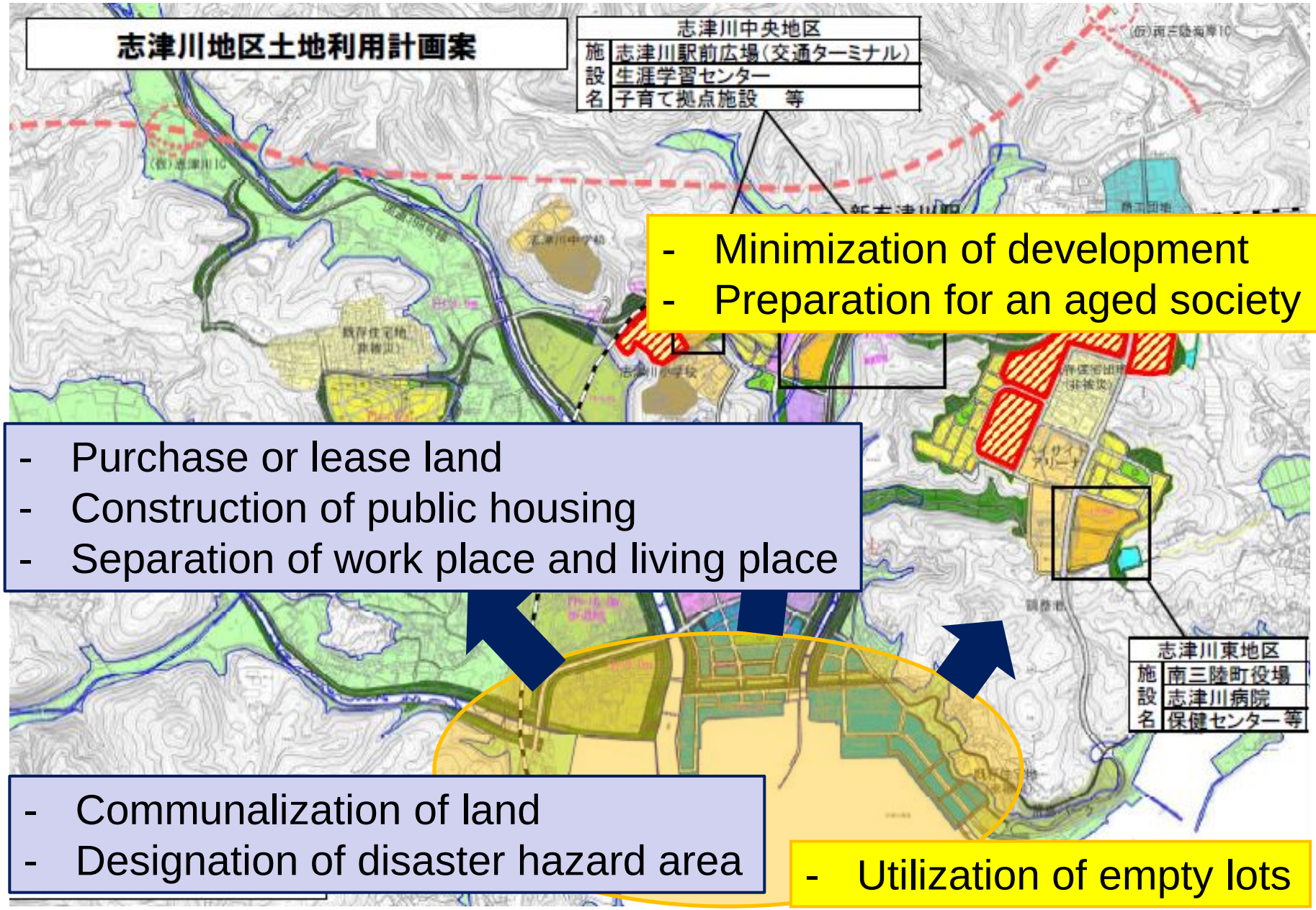


Figure 14: Exemplary concept for retreat. Source: Ubaura (2013)

Relevance of changes

- Decisions in the area of so called “traditional” risks are based on probabilities because they are past-oriented and informed by statistics.
- Climate change, but also the change of socio-economic framework conditions (demographic change, globalisation etc.) lead to deep uncertainty.
- Here, consensus becomes more important, since legally binding designations are probably not justifiable any more.
- Moreover, management measures needs to be accepted for implementation.
- Strategies are needed to anticipate uncertainty.

4. Disaster risk assessment and Impact Assessment

- An appropriate procedural framework for risk assessment would be indispensable to reach the mentioned EU environmental objectives and coordinate the several risk-related directives.
- For that purpose, the directives 97/11/EC (Amended Environmental Impact Assessment“) and 2001/42/EC (“Strategic Environmental Assessment”) offer appropriate legal basis.
- The material scopes of the EIA as well as SEA refer to plans/projects which are likely to have significant effects on the environment.
- Article 3 EIA: “The EIA shall identify, describe and assess […] the direct and indirect effects of a project on the following factors:
  - **human beings**, fauna and flora;
  - soil, water, air, climate and the landscape;
  - **material assets** and the cultural heritage;
  - the interaction between the factors mentioned in the first, second and third indents.”

- Proven by recent amendment of the EIA directive (EC 2012): “The environmental impact assessment shall identify, describe and assess […] the direct and indirect significant effects of a project on the following factors: (e) exposure, vulnerability and resilience of the factors referred to in points (a), (b) and (c), to natural and man-made disaster risks."
- Guidance Documents on Integrating Climate Change and Biodiversity into EIA and SEA (European Commission 2013, 2013a): „In addition to climate scenarios, it is important to consider socio-economic scenarios as this will help assess future vulnerability to climate change.“ (European Commission 2013a, S. 39). Impoact of climate change on result of asssment through so called „Evolving baseline trends“ (p. 39).

The following risk-related aspects have to be regarded particularly (see Annex III EIA directive):

- the extent of the impact (geographical area and size of the affected population),
- the transfrontier nature of the impact,
- the magnitude and complexity of the impact,
- the probability of the impact,
- the duration, frequency and reversibility of the impact.

The corresponding SEA requirements (Annexes I and II SEA directive) are more spatially oriented

- spatial extent of effect,
- value and vulnerability of the area
- cumulative effects.

- Thus, a material interrelationship between risk assessment and the key objectives of the EIA and SEA is clearly visible.
- Moreover, an increasing damage potential (vulnerability) or impact on the hazard potential as a consequence of the realisation of a plan/project can be understood as a significant effect on the environment.

- The procedures, carried out within both directives, correspond in an almost ideal way with the usual steps of a risk assessment process, as shown by the following table.
- EIA and SEA are well established by legislation and can be described as an existing procedural framework for managing the environment in general and especially risks from natural as well as technological hazard threatening the environment.
- This framework can be understood as a great chance for establishing risk assessment as an obligatory task within every decision about a spatial plan/programme as well as project.
- Prerequisite: communicating importance of natural hazards for SEA/EIA, probably amendment of directives in order to guarantee for an obligatory consideration of effects of the environment on plans/projects.
- Important challenge in dealing with risks, to be discussed more in detail: recreating trust in public decision-making.

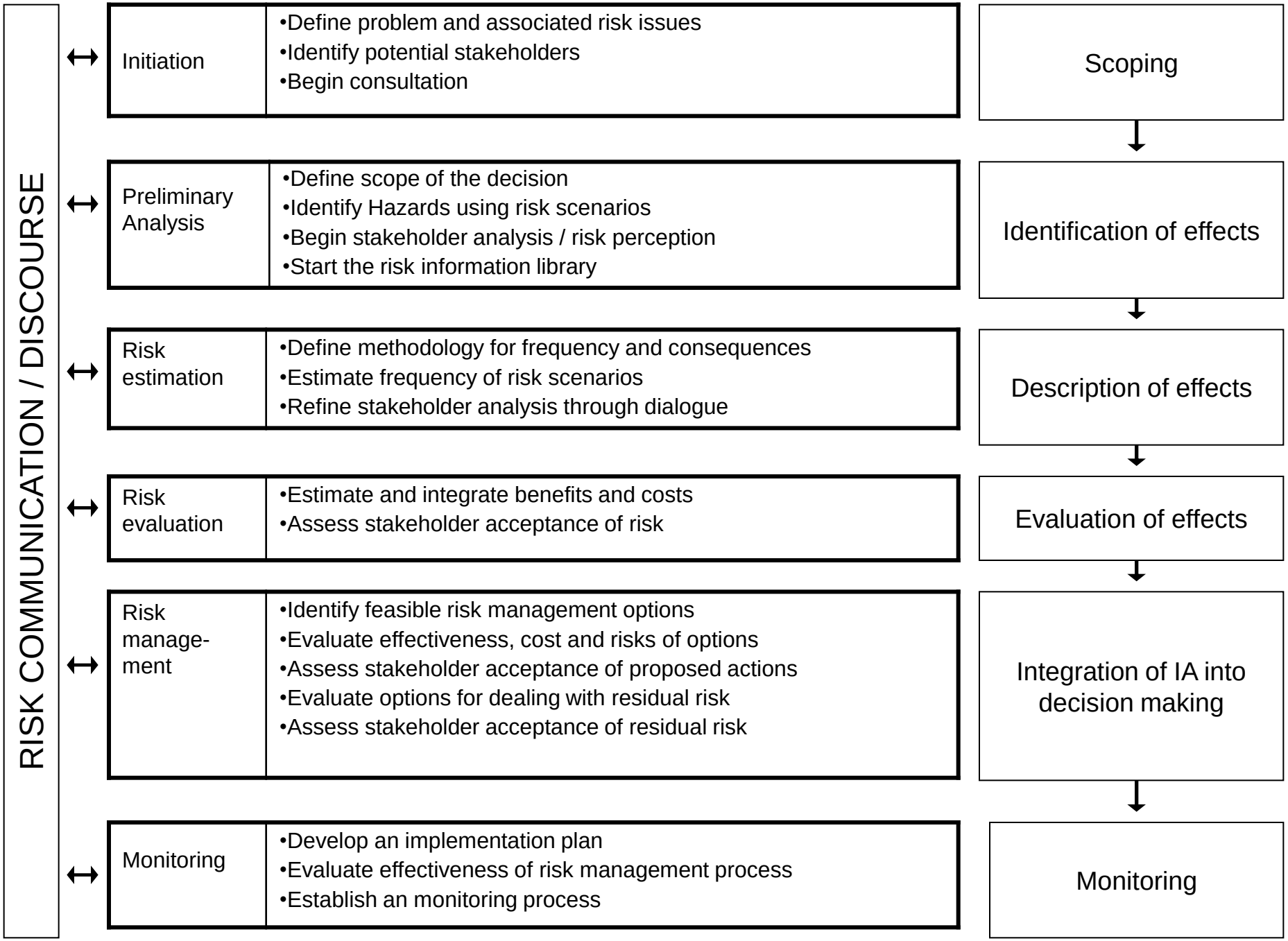


Figure 15: Steps of the Impact Assessment. Dource: Own figure

5. Conclusions – strength and weaknesses of spatial planning

Task	*Milestones*	*Potential of spatial planning*	*Description*
Assessment of long-term consequences	Assessment and appraisal of risk and its impact on the human-environmental-system	fair	Possible based on regional impact studies, planning has to have at hand. A strength of comprehensive planning is the traditionally integrated view on different change processes (demography, economy, environment, climate)
	Assessment of frequency and magnitude of extreme events	poor	That is clearly a task for specialised authorities like water management where spatial planning does not have any competence at hand
Change proofing	Identification of interaction between land-uses and the changing risk	good	Such assessments can easily be integrated in the strategic environmental assessment which is obligatory for any spatial plan or program
	New guiding principles (such as “resilience”) suitable for the ongoing global change	good	The concept of resilience is almost in line with existing planning principles like decentralised concentration and could therefore easily adopted in planning practice

Task	*Milestones*	*Potential of spatial planning*	*Description*
Adaptation	Avoidance of non-adapted developments	good	This is in focus of planning which is very much about future developments. The effectiveness of actions depends partly from the existing regulatory framework (zoning instruments)
	Adaptation of existing spatial structures (settlements, infrastructure)	poor	Any adaptation of existing structures is hardly possible through regulatory planning due to the given private property rights. What is needed are incentives and good practices aiming at convincing private householders
	Keeping disaster prone areas free of further development	good	At least conforming planning systems have regulatory zoning instruments at hand. Keeping free of areas prone to extreme events is thereby possible
	Differentiated decisions on land-use according to the given vulnerability	fair	Almost possible, but not effective with regard to existing settlement structures
	Relocation/retreat from threatened areas	poor	In conflict with property rights. Full recompensation is needed which fails mostly due to the lack of financial resources. Possible in the aftermath of a disaster or in areas with shrinking population where the existing building stock will be (partly) deconstructed based on planning strategies (see Eastern Germany)

Literature

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