Applicability and appropriateness of risk prevention measures in mountain areas – assessment of the Hazard Zone Plan (HZP) in South Tyrol – an Applied Risk Management tool

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Abstract

This contribution assesses the recently introduced hazard zone planning scheme in South Tyrol. It connects the observations and results of two independently conducted research projects, assessing on the one hand its long termed climate change (CC) appropriateness and on the other hand its short termed applicability on the ground. The unification of both results allows a holistic evaluation of the hazard zone planning scheme from twofold perspectives in matters of time and content. In long term, hazard zone planning seems to be an appropriate tool as it carries the capacity to include climate related changes in hazard and land-use characteristics. In a shorter perspective, besides its advanced legal integration of a risk based approach current organizational pitfalls, such as missing coordinating and communication structures are revealed.

Keywords: hazard zone planning, risk governance, climate change adaptation

1 Introduction

The Autonomous Province Bolzano – South Tyrol – situated in the middle of the Alps – is facing challenges due to its alpine landscape. 86% of its provincial area is located higher than 1,000 meters above sea level (Pollinger et al. 2004). Only 6.6% (48,612 ha) of the entire province are appropriate for settling. Thereof 21,096 ha (2.85% of the provincial area) are currently settled (ASTAT 2008). Nevertheless these settlements are exposed to hydro-geomorphologic hazards. Floods, avalanches, landslides, debris flows and rock-falls are endangering settled zones.

In addition to the existing structural protection measures, hazard zone planning was recently introduced in South Tyrol. Hazard zone planning serves as a non-structural, long term protection measure against natural hazards. It replaces a heterogeneous system of local expert opinions (PA 1975) and is following the EU directive on the assessment and management of flood risks (EC 2007). Hazard zone planning in South Tyrol is consistent, risk based and legally binding throughout the entire province and its 116 municipalities (GD 2008b). Referring to the Swiss Method (BUWAL 1998) and the Austrian solution (§11 des FA, 1975), the hazard zone planning approach of South Tyrol can be understood as one of the most innovative and up to date hazard zone planning scheme in the European alps.

This contribution assesses the applicability and appropriateness of hazard zone planning in South Tyrol, as an alpine risk prevention measure. It connects observations and results of two independently conducted research projects. The CC fitness and vulnerability analysis is contributed from the Alpine Space Project CLISP – CC Adaptation by spatial planning whilst the communication analysis was done on behalf of the Autonomous Province of Bolzano, Dept. of Hydraulic Engineering. The unification of both allows a holistic evaluation of the hazard zone planning scheme from twofold perspectives in terms of time and content.

In a long term perspective, we focus on CC adaptation capacities in hazard zone planning. Intensities of hydro-geomorphologic hazards and their frequencies of appearance are hardly predictable. Residual risks of damage to buildings, infrastructure and harm to people will always remain (Holub et al. 2009). Mountain areas react particularly sensitive on the consequences of global CC (e.g. Solomon et al. 2007). Major shifts in the intensities und reoccurrence periods of geomorphologic hazards are expected in mountain areas. What does that mean? Facilities dimensioned to protect urban zones from natural hazards with a recurrence probability of 150 years may in future only be appropriate to prevent against events with a recurrence probability of about 100 years (Hübel et al. 2009). Hence as it seems to be expectable that in future CC consequences increase the vulnerability of urban zones, we have to ask: is South Tyrol's HZP appropriate to enable adaptation to these changing conditions? Does it protect lives, settlements and economic areas sufficiently? Assessing vulnerability and CC fitness in hazard zone planning is long term oriented. Relevant risk phenomena of the HZP exceed obviously our daily live imaginations, as hazard reoccurrence periods of up to 300 years illustrate. Nevertheless spatial effects and utilisation restrictions of the HZP are realized within years.

In short temporal and application oriented perspective the challenges in hazard zone planning and risk prevention are not primarily technical or economical ones. It is more a matter of acceptance, awareness and mutual trust and collaboration among multiple actors in risk governance. Communication between all involved actors is considered as a key element to apply risk governance (Renn 2008; Walker et al. 2010). Thus it has to be asked: Are the established communication structures in hazard zone planning appropriate for the functionality and effectiveness of risk reduction in South Tyrol? What are the pitfalls and opportunities in the application of hazard zone planning in a communication based perspective?

Both approaches follow and accompany those ongoing hazard zone planning processes. On the one hand it is analysed if the hazard zone planning scheme is in long term an appropriate tool for CC adaptation and for reducing vulnerability. In contrast its short termed applicability and feasibility in existing governance structures is evaluated by communication analysis. The common goal is to raise satisfaction, acceptance, efficiency and long term risk reduction.

2 Material and methods

To enlighten these issues, the experts views from different provincial departments, from technical bureaus/civil engineers as well as authorities and stakeholders from municipalities were caught through standardised questionnaires and participating observation of coordination meetings. Therein quantitative and qualitative information was collected. Combining this enabled the qualitative assessment of the experts and stakeholders views and secondly some of these issues were surveyed in the questionnaire with a five step ordinal scale (Linkert Scale).

In the preparation phase for the empirical work the legal foundations were studied: Art.22/bis of the spatial planning law (PA 1997), Governor's Decree (GD 2008b); guideline for elaborating the HZP (GL 2008a) and the spatial planning and development plan (LEROP 1995) of South Tyrol as well as state law n° 267 (L 1998) and state law n° 365 (L 2000). Besides publications of the Dept. for Spatial Planning (Weber 2009) and a seminar report dealing with stakeholder challenges to implement the HZP (Bauakademie Bergmeister 2010) were integrated. Furthermore previous scientific observations on hazard zone planning in South Tyrol provided relevant input (Link 2008; Weber 2010; Lanz 2011).

Strengths and weaknesses regarding the implementation of the HZP in long term and its appropriateness towards CC adaptation and vulnerability were evaluated by eight expert interviews. These interviews were done personally following the collecting principle. The questionnaire enabled the interviewee to draw a general picture of the CC situation in South Tyrol. Emphasize was put on the problem awareness and political willingness and the society's awareness regarding CC and its regional consequences. Beside the interviewees got confronted with detailed issues regarding the HZP and its central task to protect settled areas and infrastructure from hydrogeological hazards. Its flexibility regarding the interpretation of the guidelines or the ability to modify the plan after it was approved, as well as its legally binding character and options for coherence and synergies with other spatial planning instruments. Finally, experts were asked to reflect on the efficiency and effectiveness of the hazard zone planning scheme and its implementation. In this context they referred on the appropriateness of hazard zone planning regarding CC adaptation and estimated, whether historical events have a reasonable impact for assessing future CC hazards. Their professional experiences from implementing hazard zone plans were reported in an analysis, listing the strengths and weaknesses of hazard zone planning in South Tyrol (Table 1).

The communication analysis in contrast reflects in a shorter temporal scale on the involved stakeholders and their communicative interactions during hazard zone planning. Therein communication is analysed on two distinct levels. The internal level of communication focuses on representatives from five provincial authorities (Dept. of Hydraulic Engineering, Dept. of Civil Protection, Dept. of Geology, Dept. of Forestry, Dept. for Spatial Planning), municipality representatives and civil engineers. Participative observation was applied in 13 coordination meetings amongst them. Coordination meetings are facultative for the representatives of all actors on the internal level of communication and allow therefore direct and unbi-

Table 1: Strengths and weaknesses for implementing the HZP.

Strenghts	Weaknesses
Participation of experts from technical departments	
experts from several disciplines	elaboration process, applicability, revision
distribution of responsibility/liability	
thematic maps, data sets	data-flows, data-formats, data-security
Responsibility of the municipalities	
municipal participation	legal responsibility, financial burden
coordination of the HZP and the ULP	capacity deficits
Flexibility	
revision of the HZP (at least every 10 years)	bureaucratic effort
simulation of hazard events	unfavourable chaining of events
adaptation of the specific risk – vulnerability	neglected maintenance of protective constructions
Effectiveness though conflict potential	
spatial planning strategy – cost transparency	decrease of available urban land
replenishment areas	conflicts of interest – appeals
relocation of cubage within "agricultural grassland"	property rights: red-zones in settlement areas
	scattered buildings or farms in red-zones
	re-dimension of protective constructions
retention areas, ecological renaturation sites	narrowing business locations – uncertainty of CC

ased insights in the ongoing communication processes between them. The external side in communication is made up by the general public. A standardized questionnaire was identically applied in eight municipalities (Figure 1), purposively chosen to cover the diversity of South Tyrol in matters of economic structure, altitude, settlement size, local culture and progress stage of local hazard zone planning. 403 filled questionnaires allow a representative analysis of the people's knowledge, their attitude and expectations towards hazard zone planning (Link et al. 2010; Lanz 2011). The combination of the core results from both observations sketches the current status quo of communication in hazard zone planning. It builds the foundation to derive actors' communication characteristics and to evaluate the currently established communication structures in hazard zone planning in the light of risk governance demands in South Tyrol.

3 Results

First the procedure of hazard zone planning and its strengths and weaknesses in regard to vulnerability and CC adaptation are highlighted. The communication analysis focuses on the actors' involvement, capacities and their mutual interactions in order to identify pitfalls and potentials for improvements.

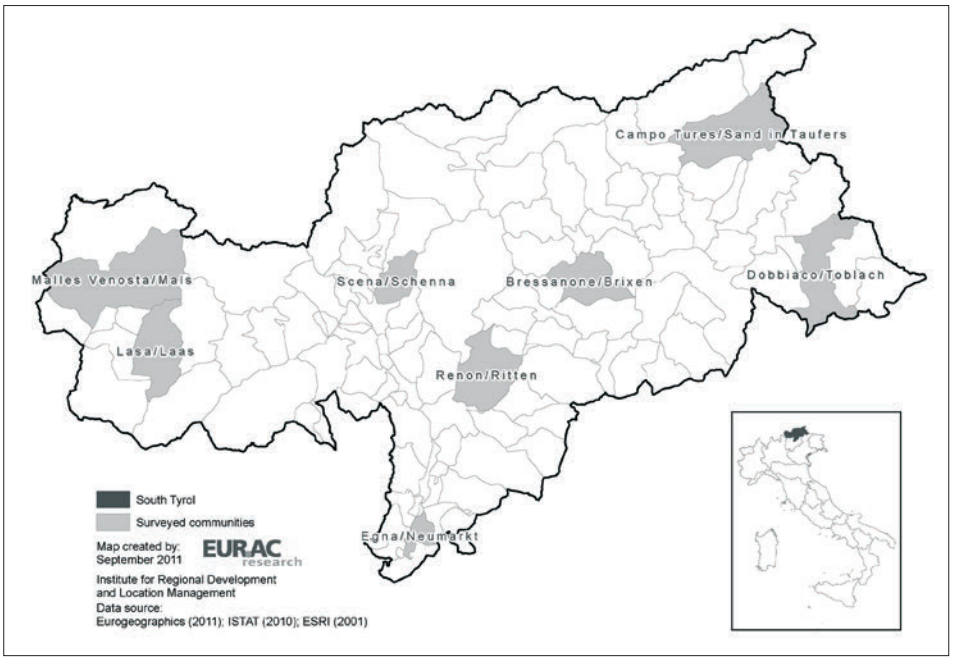

Figure 1: Surveyed communities in external communication analysis.

3.1 Reducing vulnerability and CC adaptation

A novelty of hazard zone planning in South Tyrol is the delineation of hazard zones with different degrees of endangerment for urban areas and their legally binding character for the urban land use plan (PA 1997: Article 22/bis). Municipalities are now forced to apply the derived hazard zones in their local spatial planning policies.

Structural vulnerabilities play a main role in hazard zone planning. A guideline for elaborating the HZPs (GL 2008) defines the specific risk to avert damage according to the degree and type of hazard-level (H1–H4[1]) and the vulnerability level (V1–V4[2]). The planning area of interest is defined through existing and planned settlement areas and the infrastructure facilities. Depending on the degree of public impact (lives, objects, infrastructure etc.) the area is separated into three categories with a different deepness of processing-scales and tasks. The process for defining the specific risk is the core element for establishing the risk zone map. The specific risk is determined in two phases. Firstly the hazard zones are delineated independent of existing objects considering the frequency and intensity of hazards. In a second step the different zones of hazard-levels are combined with vulnerability-levels of urbanised and settled zones. The resulting matrix (specific risk zone map) assesses

[1] H4 – Red zone: very high danger; H3 – Blue zone high danger; H2 – Yellow zone: medium danger; H1 – Grey zone: low danger consisting of phenomenon's of remaining risks

[2] V4: very high risk; v3: high risk; V2: medium risk; V1: low risk

the expected damage in urbanised areas in respect to intensity and recurrence-probability of hazards in a snapshot.

Although the primary guideline interest focuses on structural vulnerability, hazard zone planning also has to consider very much issues dealing indirectly with CC adaptation. To derive the specific risk – a combination of expected vulnerability and hazard intensity – the simulations depicting the risk level of hazard zones assume reoccurrence periods of 100 to 300 years. Therein protective constructions have a declining impact on the hazard level. Hence the simulation process has to consider CC effects crucially. The targeted revisions of the HZP, every ten years, allow ongoing adaptation of the plans.

Result evaluation of eight expert interviews on the main issues are summarized in Table 1, indicating the "strengths" and "weaknesses" of hazard zone planning. Special regard laid on the current implementation-state and the challenges and consequences of CC on a probable vulnerability rise.

Drafting and implementing a HZP is entrusted to experts from several disciplines. This ensures a comprehensive multi-hazard assessment. In contrast bureaucratic procedures and decision making processes become more complicated. No central administrative department at province-level is responsible for coordinating the elaboration and implementation of hazard zone planning. Hereon efficiency is suffering. Not only is the current implementation thereof affected but also the documentation of the associated data (data-flows, data-formats, data-security). This is relevant as the plans should be updated every ten years.

Efforts of the Provincial Government to promote municipal participation in the hazard zone planning process might conceal an attempt to transfer a great share of the implementation costs to the municipalities. This leads to the creation of a heavy financial burden for the municipalities but puts them also in a position of power as they can state their own decisions and achieve hence wider acceptance among citizens. In exchange municipalities often suffer from capacity deficits. For technical and organisational reasons it is difficult for them to influence hazard zone plan creation, maintenance and review processes or to cope with damaging events. This is also true on the coordination with ULP.

Should the natural framework conditions of a specific urban settlement change due to extraordinary events (windblasts, flooding or debris flow) the associated hazard zone plan has to be adapted immediately (GD 2008b: §13). The delineation of hazard zones foresees a simulation procedure to estimate hazard intensities in settled areas for reoccurrence probabilities 1/30, 1/100, 1/200 and 1/300 years for various types of hazards are simulated, accompanied by field surveys and historical analyses. Unfavourable chaining of events, which could amplify the catastrophic effects of hazards (Holub et al. 2009) are thereby not considered.

The introduction of hazard zone plans forces municipalities to long term spatial planning. For new building projects in settled areas, replenishment areas have to be taken into account foremost to prevent urban sprawl. It is argued, that red zones (general building ban) will cause a remarkable decrease of building land. Our results show, that this fear is rather begotten by land speculators, who will be obliged to book higher value losses for their developed or developable building land, if these

areas end up in a red zone, although most municipalities have sufficient replenishment areas. The potential cut of property rights in affected zones on developed or developable plots causes conflicts of interest and appeals. They might delay implementation for an indefinite time. On the contrary, red zones can be reduced to a small or residual level through structural protective measures. Thus owners themselves have the ability to install protection structures to reduce the specific risk on their plot. Within agricultural grassland another option is to relocate the cubage of scattered buildings in very high and high endangered zones (PA 1997: § 107).

The uncertainty of the reoccurrence probability of hazards remains, especially under CC conditions. Accordingly it appears politically and economically irrational to narrow business locations in expectation of simulated, local uncertain consequences of CC. The question remains: Do we want to spend the money for building or re-dimensioning protective structures or do we simply hope that the existing protective measures will be also sufficient in future? Apart from this speculative question the introduction of hazard zone planning directly influences the spatial planning strategy of municipalities. It will no longer be possible to dedicate unfavourable natural sites with particular building specifications as favourable and cheap building land. In the long run this cost transparency, considering follow up costs for the required additional technical facilities and their maintenance, helps municipalities to put their spatial planning strategy into practice and to reduce vulnerability and thus costs.

3.2 Communication analysis

Whilst technical, institutional and legal aspects impact complex governance tasks, such as hazard zone planning, in the long run, soft factors, as communication environments, mainly shape the acceptance and therefore effectiveness of such tasks in short run. Therefore the communication structures in hazard zone planning were assessed in detail, on both levels of communication, internal and external. An analysis of the communication characteristics of all involved actors completes the picture.

Internal communication in hazard zone planning focuses on the interactions of the involved provincial authorities, civil engineers and municipality representatives. It is strongly characterized by the tight personal relationships among the actors in different positions. This represents strengths when it comes to process ownership, interdisciplinary cooperation and mutual trust between the involved institutions. Specialised knowledge and relevant experience are strongly connected to key persons, representing a weakness of the communication system in case of individual absent. Internal communication analyses shows gaps between theoretical requirements and practical implementation even in well advanced risk management concepts. Internal communication in hazard zone planning lacks project management structures, defining work packages, responsibilities and contact persons for all involved actors. This diminishes the effectiveness of the planning process and obstructs external communication efforts, especially when it comes to complex participation processes.

The external level of communication in hazard zone planning is made up by its final target group: the public. The core results of a standardized survey (Link et al. 2010) are presented in order to evaluate knowledge, basic attitude, expectations, participative demands and communication channels relevant in hazard zone planning. Those factors are preconditions for adapted, target oriented communication. The public's general knowledge on hazard zone planning is weak. Asked about "red zone maps", just 42% of the respondents heard about it so far. Nevertheless, this ignorance is not reflected in the basic attitude of the public towards HZPs. People have positive expectations and consequences towards them and perceive them mainly as "meaningful". Even the often challenging residual risk discussion seems to be facilitated as the respondents acknowledge the limited controllability of natural hazards. Safety, legality, transparency and possibilities for participation are the most frequently named expectations towards the planning process. The public expects negative personal and communal consequences such as limitations of land use and costs. Beside, positive consequences like safety, quality of life and land-appreciation predominate the perception of the public. People demand specific, local information by the local authorities especially in the case of personal affection. Whilst general information on hazard zone planning and individual prevention measures are received from regional media sources. Participation possibilities are demanded by 77% of the respondents. Still, it has to be considered, that just a small share can imagine actual personal involvement.

Any communication process is considerably shaped by the communication characteristics of the involved actors. Therefore the communication characteristics of the involved stakeholder groups were assessed in regard to involvement in hazard zone planning, personal affection of the consequences, risk concepts and language style, role and power in the planning process, see Figure 2.

The representatives of the provincial authorities are key figures in the Hazard zone planning process. The initiative and conceptualisation for hazard zone planning was developed amongst them. This assures advances in knowledge, experience and ownership of all processes in hazard zone planning for the provincial repre-

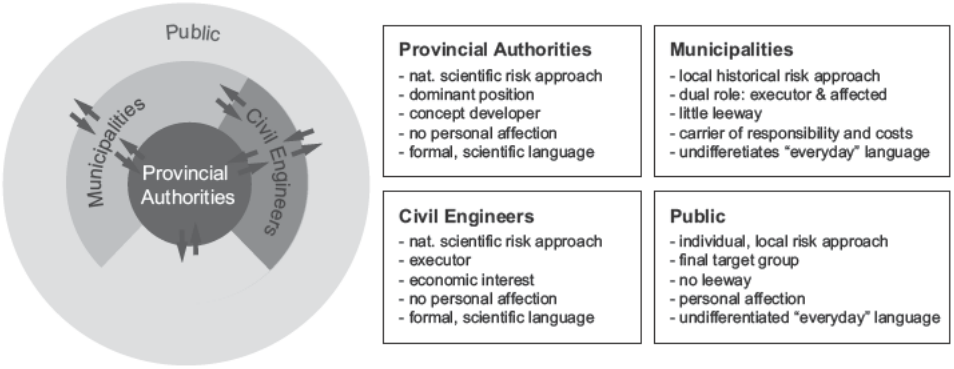

Figure 2: Interactions of the involved actors in hazard zone planning and their respective communication characteristics.

sentatives. They refer to a scientifically based, technical risk approach. Probabilities of occurrence and process intensities on the one hand and (technical) vulnerabilities paired with probabilities of presence on the other hand characterise their risk concept. Provincial representatives are neither personally affected by the consequences of hazard zone planning nor by the risks addressed. Their parlance is formal and technical, for instance a clear distinction between risk and hazard was observed. The five provincial institutions and their representatives are equally involved in erecting the plans. They consult and supervise the civil engineers and municipalities, act as information and data hubs and finally approve the plans.

The municipality representatives directly involved in hazard zone planning are mayors and municipality technicians. Their involvement is twofold. On the one hand, the municipalities have to execute the planning processes on the local scale; on the other hand the municipalities are affected by the planning results as community development options can be limited through hazard zone planning. The municipalities bear the majority of the costs, but, according to the legal rules, municipalities have no leeway in the erection of their local HZP. The style of speech at community level differs from provincial level. A more common parlance is applied at municipality level, e.g. HZPs are called "red zone maps" by municipality representatives as well as the public. This indicates a negative reception of the planning tool at its final target group. The risk concept of the municipality representatives is shaped by local historical and personal experiences, in which probability concepts or global climate developments are not implied.

The civil engineers are contractors of the municipalities in the hazard zone planning process. In most cases, several disciplinary professionals build a consortium to bid for the erection of a municipality's HZP in a public invitation to tender. The winning consortium is executing the planning process following the implementing regulations decreed by the provincial government. The interest of the civil engineers is mainly economical and as outsiders they are not personally affected by the consequences of hazard zone planning. Their risk concept is technologically driven and based upon natural laws, simulation data and personal disciplinary experiences. It focuses on hazard processes and structural prevention possibilities, (social-) vulnerabilities and non-structural prevention are almost neglected. This concept is also reflected in their scientifically based language.

The people, as the most diverse group of actors, are the final target group of hazard zone planning. Positive and negative consequences of hazard zone planning will directly affect personal property of selected individuals. Public participation in the planning process is limited to the possibility of objection within 30 days prior to governmental permission. Furthermore community assemblies on the topic are recommended. The analysis revealed wide-ranging ignorance of hazard zone planning by the respondents paired with a positive basic attitude towards it. It showed also a common need for information and participation on the topic.

4 Discussion & conclusion

Hazard zone planning in South Tyrol has just been launched and only a few municipalities have implemented it until now. Little experience has been gained in practice so far. Nevertheless, all involved actors agree that the hazard zone planning scheme is applicable and enforceable. It has great potential in governing vulnerabilities of urban areas with regard to hydro-geological hazards and the local CC consequences of CC. No explicit CC related measures are integrated in hazard zone planning, but CC consequences are indirectly considered within the long term reoccurrence intervals of the simulated hazard processes, also taking into account protective structures. Hazard zone planning implies great challenges in a short termed application oriented perspective, as shown through the multiple stakeholders' characteristics. Hazard zone planning is likely to generate conflicts due to the various different interests of stakeholders. Uncertainty regarding the impact on market values of land, properties and prospected building zones, particularly in "red zones" where no new buildings or enlargements are allowed, fuel the conflicts. Liability questions are yet unsettled. Hazard processes don't stop at administrative borders. Thus harmonised approaches how to deal with inter-communal cooperation have to be developed. Public opposition against hazard zone planning may not only undermine the effectiveness of hazard zone planning and lower public risk awareness but also result in appeals causing delays and additional costs. Municipalities primarily tend to avoid conflicts and to save cost in the preparation and implementation of hazard zone plans. The less endangered zones are identified, the better and cheaper it is. Guidance in the process of preparation and the approval by the provincial authorities are therefore crucial factors in quality management. The provincial authorities play the leading part role in hazard zone planning. The current non-hierarchical organisation structure amongst five involved institutions raises doubts over coordination efficiency, satisfaction for the subordinated actors as well as data availability and readability, also when it comes to the revision of the plans within 10 years. Project oriented organisation structures, as currently applied in hazard zone planning; seem not to be appropriate in the long run for such an ongoing, interdisciplinary spatial planning issue. The establishment of a central post for all hazard and risk plan related issues is therefore proposed. Possible tasks for this institution are manifold, e. g.: Risk awareness campaigns; promotion of individual prevention; target group oriented information; coordination on provincial and (inter-) municipal level; documentation; data storage; clearing board. A rise of transparency and efficiency is thereof expected in short notice. In a longer temporal perspective, advances in hazard zone planning and risk governance in general as well as adaptation to changing conditions will be eased thereof. In addition, the designation of hazard zones has to be integrated in a holistic risk governance concept, where also cost/benefit analysis and prioritisation of active prevention measures as well as insurance models are discussed.

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