

1 **What Does Nature Have to Do with It?**
2 **Reconsidering Distinctions in International Disaster Response Frameworks in the Danube**
3 **Basin**

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13
14 **Abstract**

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16 This article examines the international policy and institutional frameworks for response to
17 natural and man-made disasters occurring in the Danube basin and the Tisza sub-basin, two
18 transnational basins. Monitoring and response to these types of incidents have historically been
19 managed separately. We discuss whether the policy distinctions in response to natural and man-
20 made disasters remain functional given recent international trends toward holistic response to
21 both kinds of disasters. We suggest that these distinctions are counterproductive, outdated, and
22 ultimately flawed, illustrate some of the specific gaps in the Danube and the Tisza, and conclude
23 by proposing an integrated framework for disaster response in the Danube basin and Tisza sub-
24 basin.

25
26 **Keywords:** International Disaster Response Frameworks; Natural Disasters; Man-made
27 Accidents; Industrial Accidents; Natech Accidents; Danube River basin; Tisza River Sub-basin

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39 **1 Introduction**

40 The actors engaged in disaster response¹ have historically been determined by the nature
41 of the disaster (i.e., natural disaster, industrial accidents, nuclear accidents, marine oil spills), and
42 legal frameworks typically divide response between natural and man-made disasters. However,
43 there is growing recognition that anthropogenic climate change and other human activities such
44 as land use change are driving more extreme and sometimes cascading events (Sun, 2016).
45 Cascading events refer to cases in which a primary threat is followed by a sequence of secondary
46 or additional hazards that require complex and often overlapping types of response (Pescaroli
47 and Alexander, 2015). We conjecture that the tight coupling of human and environmental
48 systems and the intensive nature of natural resource extraction and management, industrial
49 activity and agriculture have increased the risk of cascading events. Thus, the question of
50 eliminating the natural/man-made dichotomy in disaster response policy is brought to the
51 forefront. We focus on transboundary response frameworks because they present exceptional
52 logistical and technical challenges, particularly in watersheds such as the Danube and the Tisza,
53 where countries have very disparate histories, levels of economic development, and are governed
54 by different statutes.

55 In Europe, natural and man-made disasters combined caused total losses of US\$ 13
56 billion in 2015, of which only US\$ 6 billion were insured; the predominant losses came from
57 flood events (Swiss Re, 2016). Flooding and pollution are considered to be the primary
58 transboundary pressures of the Danube River basin; however, a number of other man-made

¹ While disaster response is considered part of the disaster management cycle, disaster management includes the application of policies and actions regarding disaster risk (i.e., prevention, preparedness and mitigation, response, and recovery). Each have their own set of policy frameworks, actors and mechanisms for implementation. This paper focuses on the disaster response phase specifically, on the policy frameworks and actors related to requesting and receiving assistance immediately following a disaster, and the legal mechanisms by which responders are deployed.

59 accidents occurred in the region (ICPDR, 2015a). Specifically, in 2000, the Baia Mare and Baia
60 Borsa mine-tailing pond failures mobilized approximately 100,000 m³ of metal-contaminated
61 water into the Tisza River, eventually polluting the Danube River and Black Sea. Since the
62 industrial accidents occurred originally as a result of significant rainfall and flooding, these
63 events are an example of what are commonly referred to as natech accidents – technological
64 accidents triggered by natural disasters – and which lack regulation to analyze, prepare for, or
65 mitigate (Krausmann, Cruz, Salzano, 2017). In 2010, an industrial accident occurred in the
66 Hungarian portion of the Danube River when a dam containing alkaline red sludge collapsed,
67 releasing 1.5 million m³ of sludge into the surrounding land (approximately 4000 hectares) and
68 waterways (including Kolontár, Torna Creek, and the Danube River), killing 10 people and
69 injuring several hundred more (ICPDR, 2010). In 2014, following Cyclone Tamara, over 1,000
70 landslide events occurred in Serbia as well as significant flooding, resulting in damage to
71 properties and infrastructure and the inundation of agricultural land. Due to concern over
72 possible breaches to mine tailing dams in the surrounding area, and the harmful effects on human
73 health, technical experts investigated mining sites and provided recommendations for local
74 evacuations (NERC, 2014). In all three disasters, the need for disaster response exceeded the
75 capacity of national actors; therefore, international response involved the United Nations, the
76 European Commission, and various other international organizations. Thus, adequate
77 international disaster response frameworks have already been put to task in the Danube and the
78 Tisza. However, while international humanitarian law is generally well defined, the law of
79 international disaster response is still incomplete (Fisher, 2008). Historically, a distinction has
80 been drawn between the scope of response to natural disasters and man-made disasters; however,
81 this distinction is absent from the 2015 Sendai Framework for Disaster Risk Reduction, which

82 adopts a multi-hazard risk approach providing management tools for disasters that are both
83 natural and man-made (UNISDR, 2015). The Sendai Framework places unprecedented emphasis
84 on the interaction between hazards (natural and man-made), exposure levels, and pre-existing
85 vulnerability (Aitsi-Selmi and Murray, 2016). It calls for improving decision making through a
86 stronger science-policy-practice interface, with four priority areas for action including
87 strengthening disaster governance with regard to shared resources and at the basin level
88 (UNISDR, 2015). The European Union's disaster response framework is also holistic and
89 includes natural and man-made disasters, and some multilateral sub-regional agreements are also
90 taking similar approaches, such as those adopted by the Association of South East Asian Nations
91 (ASEAN) and the Baltic Sea Economic Cooperation (BSEC; ASEAN, 2012, BSEC, 1998).
92 Adopting a multi-hazard, or all-hazards, approach to disaster response allows for recognition of
93 all conditions, natural or man-made, that have the potential to cause injury, illness or death;
94 damage to or loss of infrastructure and property; or social, economic and environmental
95 functional degradation (Kappes et al., 2012).

96 With international policies starting to shift toward more holistic frameworks of response
97 that incorporate both natural and man-made disasters, this article explores policy frameworks for
98 monitoring and response in the Danube basin and Tisza sub-basin, which continue to distinguish
99 between types of disasters, and resultantly have separate response options depending on the type
100 of disaster, and what the holistic frameworks trend could mean for regional institutions in the
101 study basins.

102 This article begins with an overview of the study area and a description of the methodology.
103 Next is a discussion of the historical distinctions in response between natural disasters and
104 industrial accidents – how and why they have been treated differently and how recent

105 developments in international law and practice are raising questions about the merits of these
106 distinctions. It is followed by an examination of the international frameworks governing disaster
107 response in the Danube basin and Tisza sub-basin, and an analysis of the monitoring and
108 response to natural disasters and industrial accidents in the basins. The article concludes with a
109 reflection of how the transition of international policies toward more holistic frameworks for
110 response might affect the Danube basin and Tisza sub-basin.


111 **2 Overview of study area**


112 The Danube River basin covers more than 800,000 km² – over 10 percent of continental
113 Europe – and flows through the territories of 19 countries with nearly 80 million people residing
114 within the basin. Today, 14 of the 19 countries, plus the EU, have committed to transboundary
115 cooperation in protecting the Danube via the Danube River Protection Convention (DRPC), and
116 work jointly toward the sustainable management of the Danube basin and the implementation of
117 both the European Union’s Water Framework Directive (WFD) and Floods Directive (EU FD)
118 (ICPDR 2015a).

119 Among the tributaries of the Danube River, the Tisza sub-basin has the largest catchment
120 area, and covers approximately 160,000 km² (20 percent of the Danube basin’s area), with
121 approximately 14 million people (Fig. 1). There exists a distinct socio-economic contrast in the
122 basin between western and former socialist countries, however, since the end of communism in
123 the late 1980s, the central and lower Danube has experienced a rapid shift to free market
124 democracy within the context of increased globalization, privatization, and deregulation. This
125 has been accompanied by changes in governments and institutions, affecting the continuity of
126 policies and international arrangements which could potentially impact the international
127 frameworks countries adhere to.



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129 **Fig. 1** Map of Danube River basin and Tisza River sub-basin. Source:  the authors.

130 International measures regulating the Danube were first undertaken in 1882 for flood protection
 131 and navigation. Dams were constructed within the upper basin for flood mitigation, hydroelectric
 132 power generation, and regulation of river levels for navigation. The operation of these dams has
 133 been associated with altering the flow regime of this segment of river and consequently varying
 134 the ecological disturbance regime within the river and on the floodplain resulting in substantial
 135 changes in the riverine ecosystem (ICPDR  2009a). The flow regulation provided by the dams
 136 and the construction of levees has allowed for the conversion of floodplains and riverine
 137 wetlands into areas suitable for agricultural and urban development. Today, only 12 small
 138 reaches (<1 km in length) of the Upper Danube remain relatively untransformed (Schneider,

139 2010, 197). In the Middle and Lower Danube, the river bed has been dredged repeatedly to
140 maintain a navigable river channel. Along these segments of the Danube River, levees and dams
141 mitigate or prevent inundation of over 72 percent of the floodplain. The substantial reduction in
142 Danube's connection with its floodplain combined with wastewater discharge from agricultural
143 and industrial sources, and increasing levels of pollutants along these river segments, have
144 substantially altered or damaged the riverine ecosystem and reduced the resilience of urban and
145 rural communities to large floods, which exceed the protection level of their flood mitigation
146 measures (Schneider, 2010; UNECE, 2011). The degree of industrial development and amount
147 of pollution created by the industrial sector varies among Danube countries. In general, pulp and
148 paper industries represent the largest contributors of pollution, followed by chemical, textile, and
149 food industries (ICPDR 2009a).

150 The Tisza headwaters are located in the Carpathian Mountains in Ukraine. From these
151 headwaters the Tisza River flows southwest across central portions of the great Hungarian Plain
152 into the Danube River in Serbia (Fig. 1; ICPDR, 2008). Intense, concentrated rainfall and the
153 steep terrain coupled with deforestation and channelization of many streams result in some of the
154 most sudden and high-energy flooding in Europe (Nagy et al., 2010). The sudden water level
155 rises, coupled with the high energy of the flows, often threaten human lives and result in
156 substantial damage to infrastructure and croplands (ICPDR, 2008).

157 While industrial production has dropped drastically in the Tisza region since the 1990s, a
158 variety of industries remain, and the legacy of heavily concentrated industrial activities continues
159 to threaten the surrounding ecosystems. The main industrial regions of the Tisza sub-basin are
160 located in Romania and Hungary, where the potential for flood damage and losses is also
161 greatest. Chemical and petrochemical industries (including oil refinery, storage, and transport)

162 are important for both Hungary and Ukraine, and the cellulose and paper, textile, and furniture
163 industries are also present predominantly in the upper portion of the Tisza in Slovakia, Romania,
164 and Ukraine (ICPDR, 2011).

165 Mining activities, and the accidental spills of chemical substances, have affected the
166 aquatic environment and water quality within the Tisza sub-basin, as exemplified by the 2000
167 Baia Mare and Baia Borsa natech accidents (JEU, 2000). Natech accidents present significant
168 challenges, as natural events can trigger multiple and simultaneous accidents in one installation,
169 or depending on the impact of the natural hazard, in several hazardous facilities at the same time
170 (Krausmann and Baranzini, 2012). A 2009 assessment identified more than 92 potential sources
171 for industrial and waste deposits; however, the list does not include abandoned mine sites and
172 their mine tailing dams – only those from currently operational mines (ICPDR, 2015a).
173 Therefore, the potential risk of accidental pollution could be substantially higher (ICPDR,
174 2015a). Furthermore, natechs present additional difficulties as they remain absent from disaster
175 response frameworks (Krausmann, Cruz, and Salzano, 2017).

176 **3 Methodology**

177 The policy and institutional frameworks for monitoring of and responding to natural and
178 man-made disasters in the Danube and Tisza were examined with a combination of primary and
179 secondary data collection and analysis. The primary data consisted of semi-structured interviews,
180 while the secondary data included analysis of the legally binding mechanisms, conventions, and
181 directives in the region (Table 1). A review of bilateral agreements (Table 2), and of peer-
182 reviewed publications and white papers on the provision of disaster response within the Danube
183 basin and Tisza sub-basin highlighted the international laws, policies, and institutions present in
184 the region. Semi-structured interviews were conducted over an eight-month period from January

185 to August 2013. This format of interviews was chosen so that the pre-determined set of interview
 186 questions could be expanded through the natural course of conversation and allow for a more
 187 thorough understanding of what was initially queried – in particular, each expert interviewed was
 188 provided with the freedom to express their personal views in their own terms.

189 **Table 1.** List of legally binding mechanisms for the Danube basin and Tisza sub-basin.
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Governing Body	Convention	Type of Instrument	Description of Instrument
UN Economic Commission for Europe	Industrial Accidents Convention	Legally binding for parties to convention.	Determines actions of request for assistance and response for industrial accidents specifically.
European Commission	Water Framework Directive	Legally binding for EU member states, and through Danube Convention for non-EU member states.	Sets basin-level management of water quality and quantity.
European Commission	Floods Directive	Legally binding for EU member states, and through Danube Convention for non-EU member states.	Requires action regarding flood mapping at the basin level.
European Commission	Seveso Directives	Legally binding for EU member states.	Requires corporations to list possible risk of industrial accident, and develop preparedness plans.
European Commission	Civil Protection Mechanism Directive	Legally binding for EU member states.	First EU-wide law to include multiple-hazards in disaster risk strategies.
International Commission for the Protection of the Danube River (ICPDR)	Danube River Protection Convention	Legally binding for Danube member states.	Provides integrated framework for all Danube countries to participate in basin-level management, regardless of EU affiliation.

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195 **Table 2.** List of bilateral agreements within countries in the Danube basin and Tisza sub-basin.

Countries	Transboundary Watercourses	Disasters / Emergencies
Serbia and Montenegro – Hungary	1955**	1955*
Serbia and Montenegro – Romania	1955**	Under Discussion
Austria – Hungary	1956	1959 (Floods Only)
Austria – Slovenia	1956***	1956* (Floods Only)
Hungary – Slovakia	1956*	2014 (Floods Only)
Austria – Czech Republic	1967*	1994 (Floods Only)
Austria – Slovakia	1967*	1994 (Floods Only)
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Hungary – Romania	1986	2003 (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Moldova – Ukraine	1994	-
Ukraine – Slovakia	1995	2000 (Floods Only)
Ukraine – Romania	1997	1952*** (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Czech Republic – Slovakia	1999	-
Bulgaria – Romania	2004	2004 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Bosnia and Herzegovina – Serbia and Montenegro**	-	2011 (Flood EWS)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Serbia	-	-

196 * Agreement formed with Czechoslovak Socialist Republic
197 ** Agreement formed with Yugoslavia
198 *** Agreement formed with Union of Soviet Socialist Republics
199 - No Information Available
200

201 Seventy-one interviews were conducted in various locations throughout Europe. The
202 interviews took place with experts in the International Commission for the Protection of the
203 Danube River, the expert groups of the International Commission for the Protection of the
204 Danube River (i.e., Tisza group, river basin management, flood protection, and accident

205 prevention and control), with respondents working at the national ministries, water management
206 directorates, and non-governmental organizations in the Tisza and Danube countries, as well as
207 with experts in the European Commission and the United Nations. Those interviewed were
208 chosen based on their knowledge of and work within the Danube River basin and Tisza sub-
209 basin. Specifically, all individuals interviewed held positions (as reflected in Table 3) within the
210 countries of the Danube basin and Tisza sub-basin, and were contacted through the International
211 Commission for the Protection of the Danube River (ICPDR) expert groups and through a
212 snowball method whereby one person interviewed would suggest additional people to interview.
213 Given public roles, the interviews are intentionally left anonymous to ensure candidness in the
214 responses. Thus, only the type of organization the experts work for is identified  the numbers
215 appearing in brackets in the table below refer to the interview citations in text; multiple
216 interviews were conducted within each level of governance indicated (Table 3). The
217 classification distinguishes between international (global) organization experts, professionals
218 working in institutions within the Danube basin (regional), and experts working at national
219 agencies/ministries. The questions focused on how international frameworks affected Danube
220 basin and Tisza sub-basin policies and laws, and how these were implemented in practice. The
221 interviews also elicited as the opinion of the experts regarding the adequacy of existing
222 international frameworks and their impacts on policy implementation of disaster monitoring and
223 response throughout the Danube basin and Tisza sub-basin.²

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² Questions relevant to international frameworks for disaster response included: (1) What are the respective roles in multilevel governance in regard to response for natural and man-made disasters? (2) To what extent are natural and man-made disasters included in policy frameworks for response; in what context and at what level, and what is the language being used? (3) What gaps exist between policies and practice in regard to response for natural and man-made disasters? (4) What constraints or opportunities exist in including policies for response to natural and man-made disasters; which type would be most effective and at what level?

225 **Table 3.** Organizations from which experts were drawn for interviews.

		226
International	United Nations, United Nations Economic Commission for Europe, and United Nations Environment Programme (UNEP)/UN Office for the Coordination of Humanitarian Affairs (OCHA) Joint Environment Unit [1]	227 228 229 230
Regional	European Commission [2] International Commission for the Protection of the Danube River (ICPDR) and Expert Groups (Tisza Group, River Basin Management, Flood Protection, and Accident Prevention and Control) [3]	231 232 233 234 235
National	National Ministries of Environment, Rural Development, Interior, Environment Agency [4] Water Directorates [5]	236 237 238
Non-State Actors	NGOs [6]	239 240

241 * Numbers in brackets refer to interview citations in text.

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243 **4 Distinctions between natural and man-made disasters in policy frameworks**

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245 The approaches used for describing, limiting, and categorizing disasters fundamentally

246 shape the methods for monitoring and responding to disasters. They determine the solutions

247 utilized, the resources allocated, and the governance frameworks selected by categorizing the

248 types of disaster into either natural or man-made. It is therefore important to recognize the

249 etiology of disaster to understand why the distinctions among the various types of disasters still

250 remain.

251 Natural hazards are naturally occurring physical phenomena, which can include

252 earthquakes, landslides, tsunamis, volcanoes, and floods, with a potential to create losses or

253 dangers to humans (Smith, 2013). If the potential is realized, disasters occur. These disrupt the

254 functioning of societies due to exposure, vulnerability, and risk – leading to human, material,

255 economic and environmental losses and impacts.³ Natural disasters have historically been

³ Exposure is understood as people, infrastructure and housing, production capacities and other human assets located in hazard-prone areas. Vulnerability is defined as a set of physical, social, economic and environmental factors or processes that increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards. Disaster risk is the potential loss of life, injury, or damaged assets occurring to an individual or community as a function of hazard, exposure and vulnerability (UNISDR, 2015).

256 characterized either (1) as a direct form of punishment from God for the sins of humanity, or (2)
257 in more recent history as an “act of God” that removed humans from culpability (Rozario, 2007).
258 However, such a dichotomous view masks the fact that natural disasters are a function of where
259 people reside and their overall vulnerability, including aging infrastructure, and their
260 consequences depend on people’s ability to monitor and prepare for these events (Peel and
261 Fisher, 2016).

262 Industrial and other man-made disasters are traditionally governed and responded to
263 separately from natural disasters. The fragmented nature of disaster response is a historical
264 artifact, resulting from the need to address specific types of disasters, in specific regions, or
265 response modalities. More recently, evidence of increased losses due to disasters (Barredo, 2009;
266 Cutter and Emrich, 2005), legal barriers to disaster response (Janssen et al. 2009; Venturini,
267 2012), and the absence of unified response have led to increased attention at a variety of levels
268 for more integrated international frameworks (IFRC, 2007). However, currently, natural disasters
269 and industrial and nuclear accidents have established frameworks for response, while natech
270 accidents are often missing from response programs (OECD, 2015). Natech accidents can lead to
271 the release of toxic substances, fires, or explosions and result in injuries and fatalities; therefore,
272 the lack of consideration for natech response mechanisms, planning tools or response programs
273 can be an external risk source for chemical and nuclear facilities (Krausmann and Baranzini,
274 2012). Nuclear accidents are an exception, as they are holistically covered by the Convention on
275 Assistance in the Case of a Nuclear Accident or Radiological Emergency and the Convention on
276 Early Notification of a Nuclear Accident, which were adopted almost immediately following the
277 Chernobyl nuclear accident. However, there still remains no similar overarching global
278 framework for notification or assistance in response to industrial accidents, or for natech

279 accidents more broadly (Bruch et al., 2016). Other disaster frameworks, like the Tampere
280 Convention, apply only to a single sector or area of relief. Conversely, the ability to provide
281 disaster response for natural disasters is quite broad and is included in a number of international
282 frameworks. A question of applicability of agreements arises, however, when a cascading
283 disaster or a natech occurs and multiple institutions have a mandate for response, but it is unclear
284 which institution should take the lead in responding or coordinating response efforts (Bruch et
285 al., 2016).

286 **5 Disaster frameworks in the Danube basin and Tisza sub-basin, and their treatment of** 287 **disasters**

288 The Danube and the Tisza have experienced numerous natural and man-made disasters,
289 including natech accidents (e.g., Baia Mare Cyanide Spill, Hungarian Chemical Accident, and
290 recent Serbian landslides) (European Commission, 2016). There have been over 40 reported
291 disasters in the Danube basin between 2000 and 2012, ranging from natechs to earthquakes and
292 industrial fires. A majority of them involved more than one country at the same time (European
293 Commission, 2016). However, the frameworks for disaster response at the levels of the United
294 Nations, the European Union, and those utilized by the ICPDR are restricted to particular types
295 of disaster—**monitoring** and response to flooding is the most advanced throughout the basin,
296 while pollution is monitored, but does not have the same frameworks for response. Additionally,
297 there remain a variety of natural and man-made disasters that ~~that~~ are not integrated into any type
298 of basin monitoring or response framework, including fire, and drought.

299 Response to these disasters is governed by a range of global, regional, and national laws,
300 policies, and soft law instruments, that is, “normative provisions contained in non-binding texts”
301 (Shelton 2000, p. 292). In the Danube basin and Tisza sub-basin, this includes the Industrial

302 Accidents Convention and the Seveso Directive, the Water Framework Directive and the Floods
303 Directive, as well as treaties and policies developed at the level of the Danube and Tisza. As
304 such, natural and man-made disasters continue to be treated as distinct and separate issues, their
305 monitoring and response are managed independently, and consideration for natech accidents is
306 missing from policy guidance. Here, we discuss some of the issues that have arisen from the
307 international/global and regional (EU and basin wide) frameworks for response to natural
308 disasters in the Danube and the Tisza. We consider frameworks in decreasing geographical
309 scope.

310 At the international level, since there are agencies experienced in particular types of
311 international disasters, but they are often without a mandate or capacity for response, the
312 approaches used fall under the soft law umbrella. For the Danube and the Tisza, in 1994, the
313 United Nations Environment Programme (UNEP) and the UN Department of Humanitarian
314 Affairs (DHA, the predecessor of OCHA), developed an administrative arrangement through an
315 exchange of letters (Bruch et al., 2016). The resulting Joint UNEP/UN OCHA Environment Unit
316 (JEU) plays a leading role in facilitating coordination among international organizations in the
317 event of natural and man-made disasters. This includes natech accidents, which are more broadly
318 termed environmental emergencies (UNEP, 2011). The JEU has a number of existing agreements
319 and interface procedures in place with these organizations, in order to facilitate response. For
320 example, the JEU facilitated international agreements and interface procedures to aid with
321 response between UN Disaster Assessment and Coordination (UNDAC) and the EU Civil
322 Protection Mechanism to the 2014 Serbian landslides following Cyclone Tamara (NERC, 2014).
323 During the 2000 Baia Mare natech accident in the Tisza River sub-basin, sixteen experts from
324 seven countries deployed for response to the natech accident. The JEU assisted to coordinate

325 response efforts among UNDAC, the European Commission, the Military Civil Defence Unit,
326 the World Health Organization, and a variety of other actors (JEU, 2000).

327 Also at the international level, response for industrial accidents is provided via the United
328 Nations Economic Commission for Europe's (UNECE) Industrial Accident Convention. UNECE
329 applies to land-based, non-military, and non-radiological industrial accidents, and response is
330 provided through bilateral or multilateral arrangements (UNECE, 2009). If no prior agreements
331 exist, an affected country can request assistance from other parties through mutual assistance
332 agreements. However, in these situations, it is the responsibility of the requesting country to
333 cover all costs, unless otherwise agreed upon among the responding countries (UNECE, 2009). If
334 an industrial accident occurs as a result of flooding, or other environmental effects, multiple
335 disaster response frameworks must be triggered, therefore the Convention is not comprehensive
336 enough to address cascading disasters in a holistic manner.

337 At the regional level, in our study areas, the Danube countries developed the Danube
338 River Protection Convention (DRPC) in 1994, which is a legally binding instrument that ensures
339 sustainable management of the Danube River (ICPDR, 1994). Through the ICPDR, the DRPC
340 requested the ICPDR to coordinate the activities of the EU Water Framework Directive (WFD)
341 and EU Floods Directive among the Danube member states. The WFD and Floods Directive are
342 legally binding to members of the European Union, but through the DRPC become legally
343 binding to all Danube member states, regardless of EU member status. The WFD combines the
344 monitoring and assessment of water quality in the basin, and the Floods Directive instructs
345 national authorities to establish flood risk management plans by 2015, linking the objectives of
346 the WFD and the risk to these objectives from flooding or coastal erosion through the Floods
347 Directive, and integrating them into basin level activities via the ICPDR. However, because not

348 all countries of the Danube are EU member states, not all measures and outcomes of the WFD
349 and Floods Directive are implemented equally among the basin countries. Though the Flood
350 Directive was expected to reduce flood risk, interviewees voiced disappointment regarding the
351 limitations of integrating disaster risk more broadly, particularly in relation to water quality and
352 accidental pollution [3]. Thus, the Water Framework Directive and Flood Directive have
353 substantial policy limitations to, as neither of the two directives require the integration of disaster
354 risk of both floods and accidental pollution.

355 The European Union’s Civil Protection Mechanism (EU CPM) is an instrument for
356 disaster response that protects people, the environment, property, and cultural heritage in the
357 event of natural or man-made disasters, occurring within or outside of the European Community
358 (European Commission, 2016). Disasters are monitored internationally through the Emergency
359 Response Coordination Centre (ERCC) in cooperation with the JEU and with participating
360 states. The ERCC and JEU interface with a diverse system of response among the Danube basin
361 countries due to the variety of disasters experienced. Some utilize a single Civil Protection
362 Mechanism, while others rely on multiple parties among Ministries of the Interior, Ministries of
363 Rural Development, Water Directorates, and a variety of additional local protection committees
364 [4, 5]. Interviews indicated that not all responders/parties are sufficiently trained, and many lack
365 managerial or technical capacity to manage specific disasters appropriately [4]. There is also
366 large compartmentalization of tasks at lower levels – both regional and local – where integration
367 among the various types of disaster, as well as increased cooperation is needed [2, 3]. Other than
368 the fact that these diverse actors are providing certain types of disaster assistance, there is
369 nothing uniting them – there is no international or regional disaster response system. Limitations
370 in funding, technical expertise, and capacity were confirmed in interviews with experts at various

371 levels, who also noted how this leads to uneven implementation of EU Directives within the
372 basin that can create pockets of vulnerability to both flood risk and risks from industrial
373 accidents [2, 3, 4]. Experts also expressed the need for formal agreements with specific language
374 on integrated mapping of cascading disasters, as well as provisions addressing response to both
375 natural and man-made disasters, particularly if additional grants could be given from the EU to
376 support these activities [2, 3, 4, 5]. Some interviewees reflected that the regional Danube
377 Strategy depended on stronger countries helping the weaker ones, but limitations with funding
378 and capacity are difficult to overcome [2].

379 In the 2015 Annual Report on implementation of the Danube Strategy produced by the
380 Danube countries, all projects focused on implementation of the Floods Directive. The only
381 mention of industrial accidents was to reflect the failure to include an updated Inventory of
382 Potential Accidental Risk Spots along the Danube, which is also discussed in the 2015 Danube
383 River Basin Management Plan (DRBMP) (EUSDR, 2015; ICPDR, 2015b). Given past issues
384 with mine tailing collapses and other pollution disasters associated with flooding, the 2015
385 DRBMP acknowledged the need to update the Inventory of Potential Accidental Risk Spots
386 promptly (ICPDR, 2015b). Unfortunately, this recommendation from the 2015 DRBMP, and
387 initially expressed in the first Danube River Basin Management Plan of 2009, has yet to be
388 realized.

389 The Danube River Protection Convention is supplemented by a series of non-binding
390 Memoranda of Understanding (MOU) referred to as the Danube Declarations, first agreed upon
391 in 2004, revised in 2010, and updated in 2016. Within this umbrella, the Danube River basin
392 countries engage currently in two separate systems: the Emergency Flood Alert System
393 (associated with the EU) for flood monitoring, and the Principal International Alert Centres

394 (PIACs) of the Danube Accident Emergency Warning System (Danube AEWS, not associated
395 with EU institutions) to monitor pollution from man-made accidents. These two separate systems
396 well illustrate the issues associated with separate response mechanisms and institutional
397 arrangements. The Emergency Flood Alert System has been functioning since 2003 at the Joint
398 Research Centre, a Directorate General of the European Commission, and works in collaboration
399 with the national authorities of the member states. Note that a MOU has been signed with
400 several, but not all of the Danube countries. The Emergency Flood Alert System provides
401 national authorities the ability to develop response measures, including opening temporary flood
402 retention areas, building temporary flood protection structures such as sandbag walls, and
403 adopting civil protection measures such as closing down water supply systems (ICPDR, 2009b).
404 The MOU does not include tributaries draining areas less than 4,000 km², therefore the
405 Emergency Flood Alert System neither addresses flood risks in the Tisza, nor in certain basin
406 countries where significant flood concerns arise, such as Ukraine [1].

407 The Principal International Alert Centres (PIACs) of the Danube Accident Emergency
408 Warning System monitor accidental water pollution incidents in the Danube River basin. Unlike
409 the Emergency Flood Alert System, which is linked to monitoring conducted by the European
410 Commission and is transmitted to national authorities (without involving the ICPDR in the
411 monitoring process), the Danube AEWS system is managed by the ICPDR, but does not involve
412 the European Commission. While all contracting parties of the DRPC cooperate with the Danube
413 AEWS, they also are expected to have national policies regarding response to accidental
414 pollution in the Danube that connects to the Principal International Alert Centres. The PIACs are
415 expected to operate on a 24-hour basis within each country, and are in charge of all international
416 communications. When a message of a potentially serious accidental pollution is received, the

417 PIAC is responsible for communicating the accident to the ICPDR, it decides whether it is
418 necessary to notify downstream countries and engage experts to assess the impacts of the
419 pollution, and it determines which response activities need to be taken at the national level
420 (ICPDR, 2014). Challenges to the monitoring capabilities of the Danube AEWS include
421 territorial gaps (several areas along the Danube and Tisza are not monitored) [3, 4, 5], a limited
422 number of bilateral agreements for response in case the accident exceeds national capacity
423 (Table 2), and a non-comprehensive list of man-made accidents being monitored. The failure to
424 monitor pollution events in a consistent and effective manner creates problems for downstream
425 countries [4]. This is particularly problematic in the Tisza countries where the lack of monitoring
426 of both flood and accidental pollution events, combined with limited bilateral agreements, raise
427 concern among several countries [4, 5].

428 Bilateral agreements are also in place to address transboundary flood measures among
429 Danube countries and, to a smaller extent, to respond to man-made disasters. Bulgaria, Moldova,
430 Romania, Serbia, and Ukraine are parties to the DRPC, but have separately engaged in the BSEC
431 Agreement on Response to Natural and Man-made disasters (Bruch et al., 2016). Furthermore,
432 the Danube Delta countries (Moldova, Romania, and Ukraine) are working together with the
433 UNECE Industrial Accidents Convention due to the large concentration of oil-related industries
434 in the area in order to improve hazard management, increase transboundary cooperation, and
435 strengthen operational response [1].

436 **6 Building holistic approaches for integrating multilevel disaster response**



437 While “natural” disasters may be a commonly used term, no disaster can be regarded as
438 entirely natural if people have the capacity to avoid, mitigate, or reduce the risk from it (Picard,
439 2016). Generally, the vulnerability to lives and livelihoods can be reduced with disaster

440 preparedness and response, such as the proper placement, function, and use of early warning
441 systems, and mitigation activities. Additional shifts in what is considered a natural disaster have
442 come from the acknowledgement of the anthropogenic influences on natural disasters. Besides
443 climate change, there are also induced earthquakes occurring as a result of slipping faults from
444 fluid injection in hydraulic fracturing (Legere, 2016), landslides from subsidence and increased
445 land use activities including urbanization (Smith, 2013), and pandemics from deforestation and
446 habitat conversion (Greger, 2007), to name a few.

447 Human, economic, and environmental losses can be worse in highly populated, urbanized
448 areas; with increased urbanization and climate change, these areas are placed at increased risk to
449 natural and man-made hazards (Bruch and Goldman, 2012; Huppert and Sparks, 2006). This is
450 especially true for natech accidents and other cascading disasters, since simultaneous response
451 efforts are required to attend to the industrial, chemical, or technological accidents as well as the
452 triggering natural disaster. The overlap from numerous responders, the activation of numerous –
453 and disparate – response frameworks, and the difficulties in integrating the separate response
454 activities make fragmented frameworks of disaster response costly and ineffective. Therefore,
455 expanded definitions that reflect multiple types of disaster, as well as improved comprehensive
456 response frameworks, are needed in order to recognize that many disasters can arise from
457 multiple, potentially co-located hazards, to take the necessary measures to reduce the risks of
458 those hazards and to holistically address their impacts. Otherwise, piecemeal, uncoordinated
459 responses may result in duplication of costs and activities and, more importantly, overlooked
460 health and environmental consequences.

461 The process of building holistic approaches **to planning, preparedness**, and response can
462 strengthen frameworks for responding to natural and man-made disasters (i.e., adopting a multi-

463 hazard approach). These approaches may be implemented at the global, regional, bilateral, or
464 national levels. By adopting a multi-hazard framework for disaster response, the expertise and
465 practices of responders can be increased to include improved modeling and assessment
466 approaches, response methodologies and tools, and enhanced measures to prevent or mitigate the
467 consequences from natech accidents (Krausmann, Cruz, and Salzano, 2017).

468 The review of legal and policy frameworks and interviews reflected that while some
469 **planning and preparedness** activities take place regarding flood hazard, this is not the case for
470 accidental pollution (at least in the Danube and Tisza context), and natech accidents are absent in
471 the framework language [2, 3, 4, 5, 6] (European Commission, 2010; ICPDR, 2015a).

472 **Monitoring gaps** are reported along the length of both the Danube and the Tisza for both flooding
473 and accidental pollution, and these gaps should be corrected in future planning efforts. The Tisza
474 sub-basin and smaller water bodies are beyond the scope of the WFD, consequently, no holistic
475 **monitoring** or response measures are in place; regional agreements at the basin or sub-basin level
476 could aid in developing improved response frameworks [2, 3] (McClain et al., 2016).

477 Improving the mapping of hazards to reflect not only flood hazard, but also risks from
478 man-made disasters and natech events – and integrating these risks into a comprehensive map of
479 vulnerability to disaster – would provide a foundation for more holistic policies and
480 programming to manage disaster risks. It would also aid in improving measures for **preparedness**
481 at the national and local levels. Interviews indicate that harmonized approaches to natural and
482 man-made disasters offer additional opportunities to strengthen capacity among transboundary
483 actors [1, 4].

484 In order to avoid fragmentation among response to natural and man-made disasters, and
485 empower, guide, and facilitate the institutional arrangements and mandates necessary to improve

486 these activities, the legal and policy frameworks need to provide the necessary mandates and
487 procedures – this is accomplished by incorporating an integrated, multi-hazard approach to
488 disaster response. Though this is can be challenging, there is a growing literature on the
489 development of the technical and policy tools necessary (Kappes et. al., 2012, Holub and Fuchs,
490 2009), and on how to address fairness considerations (Thaler and Hartmann, 2016). There are
491 multiple examples of more holistic and comprehensive approaches being used in the EU
492 countries (Greiving et al. 2012, Thaler et. al, 2016). Such approaches emphasize stakeholder
493 involvement and adaptive management, and could form a blueprint for efforts in the Danube and
494 the Tisza.

495 With regard to the Danube basin specifically, a more holistic approach that accounts for
496 the specific challenges of the basin could be implemented in a variety of ways. The Danube
497 River Protection Convention has not been updated or amended since it was originally drafted in
498 1994, but it unites all countries of the Danube basin and its tributaries under a formal, legal
499 agreement. Cooperation among Danube countries was generally reported as good [3]; therefore,
500 continuing the use of the ICPDR and its expert groups as a mechanism to gain cooperation
501 among the countries on a regional framework for improving **monitoring** and response could be
502 considered [3, 4, 5]. Another possibility would be to expand the numerous bilateral agreements
503 among the Danube and Tisza countries regarding flooding to also include man-made disasters
504 and natech events. Working on agreements at a regional level improves communication, breaks
505 down barriers (particularly in transboundary situations), and aids in the development of a
506 common legal language among participating parties [1, 2].

507 Updating conventions and other hard law (e.g., legal frameworks) can be difficult;
508 countries are sometimes unwilling to adopt binding obligations, particularly in the face of

509 uncertainty (e.g., climate change), or when they feel there might be a need to act quickly to
510 changing circumstances. ~~Often find~~ soft law (e.g., policies and guidelines) can be a more flexible
511 tool. In this regard, updating the Danube Declaration and the corresponding Tisza MOUs can
512 provide particularly viable options. Through the Declarations and MOUs, the Danube or Tisza
513 countries could decide whether to engage in a particular action through a separate strategy, or
514 pilot project, or whether to incorporate the issue into the broader basin or sub-basin management
515 plan (e.g., improvement of accidental pollution and flood monitoring, integrated accidental
516 pollution and flood maps). Improved vertical and horizontal cooperation was a request of several
517 interviewees, particularly in regard to the risks posed from man-made accidents and how to
518 respond to these accidents [4, 5].

519 **7 Conclusions**

520
521 The historic distinction between natural and man-made disasters is outdated,
522 counterproductive, and ultimately flawed. The recognition of this has resulted in the need to
523 address disasters holistically, regardless of the contributing causes and aggravating factors. This
524 trend is noted in the Sendai Framework, which adopts a multi-hazard risk approach and provides
525 tools for responding to disasters that are both natural and man-made (UNISDR, 2015).

526 The Danube and Tisza countries have already been affected multiple times by
527 transboundary natural and man-made disasters and natech accidents. Nevertheless, though
528 approaches for integrating holistic frameworks for disaster response are recognized at multiple
529 levels, implementation within the Danube basin and Tisza sub-basin remains distinct and
530 fragmented. While the current policy frameworks do not address monitoring and response
531 comprehensively across types of disasters, the basin countries have several options for more
532 integrated response. A key opportunity is the development or amendment of agreements

533 governing response to natural and man-made disasters. This could be negotiated through updates
534 to the Danube Convention or through bilateral treaties between the basin countries. Improving
535 planning and preparedness through more integrated monitoring and mapping of natural and man-
536 made disasters, such as combining the flood risk areas with the Inventory of Potential Accidental
537 Risk Spots, could be elaborated upon in Declarations and MOUs at the basin and sub-basin
538 levels. Such negotiations and the resulting increased coordination will become even more critical
539 as climate change is likely to increase the frequency and severity of extreme events in the
540 foreseeable future.

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550 551 **References**

552
553 Aitsi-Selmi, A., and Murray, V. 2016. The Chernobyl Disaster and Beyond: Implications of the
554 Sendai Framework for Disaster Risk Reduction 2015-2030. *PLOS Medicine* 13(4): 1-4.
555
556 ASEAN (Association of South East Asian Nations). 2010. ASEAN Agreement on Disaster
557 Management and Emergency Response: Work Programme 2010-2015. Jakarta: ASEAN.
558 [http://www.asean.org/wp-](http://www.asean.org/wp-content/uploads/images/resources/ASEAN%20Publication/2013%20(12.%20Dec)%20-%20AADMER%20Work%20Programme%20(4th%20Reprint).pdf)
559 [content/uploads/images/resources/ASEAN%20Publication/2013%20\(12.%20Dec\)%20-](http://www.asean.org/wp-content/uploads/images/resources/ASEAN%20Publication/2013%20(12.%20Dec)%20-%20AADMER%20Work%20Programme%20(4th%20Reprint).pdf)
560 [%20AADMER%20Work%20Programme%20\(4th%20Reprint\).pdf](http://www.asean.org/wp-content/uploads/images/resources/ASEAN%20Publication/2013%20(12.%20Dec)%20-%20AADMER%20Work%20Programme%20(4th%20Reprint).pdf).
561

562 Barredo, J.I., 2009. Normalised flood losses in Europe: 1970–2006. *Natural Hazards and Earth*
563 *System Sciences*, 9(1): 97-104.
564

565 BSEC (Black Sea Economic Cooperation). 1998. Agreement among the Governments of the
566 Participating States of the Black Sea Economic Cooperation (BSEC) on Collaboration in
567 Emergency Assistance and Emergency Response to Natural and Man-Made Disasters.
568 [http://www.bsec-](http://www.bsec-organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf)
569 [organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergen](http://www.bsec-organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf)
570 [cyagreement%20071116.pdf](http://www.bsec-organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf).
571

572 Bruch, C., and Goldman, L. 2012. Keeping up with Megatrends: the implications of climate
573 change and urbanization for environmental emergency preparedness and response. Office
574 for the Coordination of Humanitarian Affairs, Joint UNEP/OCHA Environment Unit,
575 Emergency Services Branch, Geneva, Switzerland.
576

577 Bruch, C., Nijenhuis, R., and McClain, S.N. 2016. International Frameworks Governing
578 Environmental Emergency Preparedness and Response: An Assessment of Approaches.
579 In *The Role of International Environmental Law in Reducing Disaster Risk*, Jacqueline
580 Peel & David Fisher eds. Leiden: Brill Nijhoff.
581

582 Cutter, S. L., & Emrich, C.T. 2005. Are natural hazards and disaster losses in the U.S.
583 increasing? *Eos, Transactions American Geophysical Union*, 86(41): 381-389.
584

585 European Commission. 2010. Communication from the Commission to the European Parliament,
586 the Council, the European Economic and Social Committee, and the Committee of the
587 Regions: European Strategy for the Danube Region. COM (2010) 715 Final.
588

589 European Commission. 2016. EU Civil Protection Mechanism. 2 July.
590 http://ec.europa.eu/echo/what/civil-protection/mechanism_en.
591

592 EUSDR (European Union Strategy for the Danube Region). 2015. Danube Region Strategy
593 Priority Area 5: To Manage Environmental Risks. Coordinated by Hungary and
594 Romania. June.
595

596 Fisher, D. 2008. The Law of International Disaster Response: Overview and Ramifications.
597 *International Law Studies* 83: 293-320.
598

599 Greger, M. 2007. The Human/Animal Interface: Emergence and Resurgence of Zoonotic
600 Infectious Diseases. *Critical Reviews in Microbiology* 33: 243-299.
601

602 Grieving, S., Pratzler –Wanczura, S. Sapountzaki, K., Ferri, F., Grifoni, P., Firus, K., and
603 Xanthopoulos, G. 2012. Linking the actors and policies throughout the management cycle
604 by “Agreement on Objectives” – a new output-oriented approach. *Natural Hazards and*
605 *Earth Systems Sciences* 12: 1085-1107.
606

607 Holub, M., and Fuchs, S. 2009. Mitigating mountain hazards in Austria – legislation, risk
608 transfer, and awareness building. *Natural Hazards and Earth System Sciences* 9(2): 523-
609 537.

610

611 Huppert, H.E., and Sparks, R.S.J. 2007. Extreme Natural Hazards: Population Growth,
612 Globalization and Environmental Change. *Philosophical Transactions of the Royal*
613 *Society* 364: 1875-1888.

614

615 ICPDR (International Commission for the Protection of the Danube River). 1994. Danube River
616 Protection Convention. Vienna: ICPDR.
617 <https://www.icpdr.org/main/sites/default/files/DRPC%20English%20ver.pdf>.

618

619 ICPDR (International Commission for the Protection of the Danube River). 2008a. Analysis of
620 the Tisza River Basin 2007. Vienna: ICPDR.
621 http://www.icpdr.org/main/sites/default/files/Tisza_RB_Analysis_2007.pdf.

622

623 ICPDR (International Commission for the Protection of the Danube River). 2009a. The Danube
624 River Basin District Management Plan: Part A- Basin-wide Overview. Vienna: ICPDR.
625 http://www.icpdr.org/main/sites/default/files/DRBM_Plan_2009.pdf.

626

627 ICPDR (International Commission for the Protection of the Danube River). 2009b. Assessment
628 of Flood Monitoring and Forecasting in the Danube River Basin. Vienna: ICPDR.
629 [http://www.icpdr.org/main/sites/default/files/OM-12%20-](http://www.icpdr.org/main/sites/default/files/OM-12%20-%203.6%20ASSESSMENTof%20Flood%20Monitoring%20FINAL.pdf)
630 [%203.6%20ASSESSMENTof%20Flood%20Monitoring%20FINAL.pdf](http://www.icpdr.org/main/sites/default/files/OM-12%20-%203.6%20ASSESSMENTof%20Flood%20Monitoring%20FINAL.pdf).

631

632 ICPDR (International Commission for the Protection of the Danube River). 2010. New
633 International System for Early Flood Warning in Danube River Basin Launched. March.
634 [https://www.icpdr.org/main/sites/default/files/nodes/documents/080310_efas_pr_final_ic](https://www.icpdr.org/main/sites/default/files/nodes/documents/080310_efas_pr_final_icpdr.pdf)
635 [pdr.pdf](https://www.icpdr.org/main/sites/default/files/nodes/documents/080310_efas_pr_final_icpdr.pdf).

636

637 ICPDR (International Commission for the Protection of the Danube River). 2011. Memorandum
638 of Understanding: Towards the Implementation of the Integrated Tisza River Basin
639 Management Plan Supporting the Sustainable Development of the Region. Vienna:
640 ICPDR.

641

642 ICPDR (International Commission for the Protection of the Danube River). 2014. International
643 Operations Manual for PIACs of the Danube AEWS. Vienna: ICPDR.
644 [http://www.icpdr.org/main/sites/default/files/nodes/documents/aews_manual_2014_final.](http://www.icpdr.org/main/sites/default/files/nodes/documents/aews_manual_2014_final.pdf)
645 [pdf](http://www.icpdr.org/main/sites/default/files/nodes/documents/aews_manual_2014_final.pdf).

646

647 ICPDR (International Commission for the Protection of the Danube River). 2015a. The Danube
648 River Basin District Management Plan – Update 2015. Vienna: ICPDR.
649 <https://www.icpdr.org/main/sites/default/files/nodes/documents/dr bmp-update2015.pdf>.

650

651 ICPDR (International Commission for the Protection of the Danube River). 2015b. Flood Risk
652 Management Plan for the Danube River Basin District. Vienna: ICPDR.
653 https://www.icpdr.org/main/sites/default/files/nodes/documents/1stdfrmp-final_1.pdf.
654

655 IFRC (International Federation of Red Cross and Red Crescent Societies). 2007. Law and Legal
656 Issues in International Disaster Response: A Desk Study. Geneva: IFRC.
657

658 Janssen, M., Lee, J., Bharosa, N. and Cresswell, A., 2010. Advances in multi-agency disaster
659 management: Key elements in disaster research. *Information Systems Frontiers*, 12(1):1-
660 7.
661

662 JEU (Joint United Nations Environment Programme (UNEP)/Office for the Coordination of
663 Humanitarian Affairs (OCHA) Environment Unit). 2000. Cyanide Spill at Baia Mare
664 Romania: Spill of Liquid and Suspended Waste at the Aurul S.A. Retreatment Plant.
665 Geneva: OCHA.
666

667 Kappes, M., Keiler, M., von Elverfeldt, K., and Glade, T. 2012. Challenges of analyzing
668 multihazard risk: A review. *Natural Hazards* 64: 1925-1958.
669

670 Krausmann, E., A.M. Cruz, and E. Salzano. 2017. Natech Risk Assessment and Management:
671 Reducing the Risks of Natural-hazard Impact on Hazardous Installations. Amsterdam:
672 Elsevier.
673

674 Krausmann, E., and Baranzini, D. 2012. Natech Risk Reduction in the European Union. *Journal*
675 *of Risk Research* 15(8): 1027-1047.
676

677 Legere, L. 2016. State Seismic Network Helps Tell Fracking Quakes from Natural Ones.
678 *Pittsburgh Post-Gazette*. June 26. [http://powersource.post-](http://powersource.post-gazette.com/powersource/policy-powersource/2016/06/26/State-seismic-network-helps-tell-fracking-quakes-from-natural-ones/stories/201606210014)
679 [gazette.com/powersource/policy-powersource/2016/06/26/State-seismic-network-helps-](http://powersource.post-gazette.com/powersource/policy-powersource/2016/06/26/State-seismic-network-helps-tell-fracking-quakes-from-natural-ones/stories/201606210014)
680 [tell-fracking-quakes-from-natural-ones/stories/201606210014](http://powersource.post-gazette.com/powersource/policy-powersource/2016/06/26/State-seismic-network-helps-tell-fracking-quakes-from-natural-ones/stories/201606210014).
681

682 McClain, S.N., Bruch, C., and Secchi, S. 2016. Adaptation in the Tisza: Innovation and
683 Tribulation at the Sub-basin Level. *Water International* 0: 1-23.
684

685 Nagy, I., Ligetvári, F., and Schweitzer, F. 2010. Tisza River Valley: Future Prospects.
686 *Hungarian Geographical Bulletin* 59(4): 361-370.
687

688 NERC (Natural Environmental Research Council). 2014. UNDAC Landslide Advisory Visit to
689 Serbia June 2014. Open Report IR/14/043. P. Hobbs Ed. Keyworth: British Geological
690 Survey.
691

692 OECD (Organization for Economic Cooperation and Development). 2015. Addendum No. 2 to
693 the OECD Guiding Principles for Chemical Accident Prevention, Preparedness, and
694 Response (2nd Ed.) to Address Natural Hazards Triggering Technological Accidents
695 (Natechs).

696 [http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono\(2](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2)
697 [015\)1&doclanguage=en.](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2)
698
699 Peel, J., and D. Fisher. 2016. International Law at the Intersection of Environmental Protection
700 and Disaster Risk Reduction. In *The Role of International Environmental Law in*
701 *Reducing Disaster Risk*, Jacqueline Peel & David Fisher eds. Leiden: Brill Nijhoff.
702
703 Pescaroli, G., and D. Alexander. 2015. A definition of cascading disasters and cascading effects:
704 Going beyond the “toppling dominos” metaphor. *Planet at Risk* 2(3): 58-67.
705
706 Picard, M. 2016. Water Treaty Regimes as a Vehicle for Cooperation to Reduce Water-Related
707 Disaster Risk: The Case of Southern Africa and the Zambesi Basin. In *The Role of*
708 *International Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David
709 Fisher eds. Leiden: Brill Nijhoff.
710
711 Rozario, K. 2007. *The Culture of Calamity: Disaster & the Making of Modern America.*
712 Chicago: University of Chicago Press.
713
714 Schneider, E. 2010. Floodplain Restoration of Large European Rivers, with Examples from the
715 Rhine and the Danube. In *Restoration of Lakes, Streams, Floodplains, and Bogs in*
716 *Europe: Principles and Case Studies*, 185–223. USA: Springer Science.
717
718 Shelton, D. ed. 2000. *Commitment and Compliance: The Role of Non-binding Norms in the*
719 *International Legal System.* Oxford: Oxford University Press.
720
721 Smith, K. 2013. *Environmental Hazards: Assessing Risk and Reducing Hazard.* New York:
722 Routledge.
723
724 Sun, L.G. 2016. Climate Change and the Narrative of Disaster. In *The Role of International*
725 *Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David Fisher eds.
726 Leiden: Brill Nijhoff.
727
728 Swiss Re. 2016. Natural Catastrophes and Man-Made Disasters in 2015: Asia Suffers Substantial
729 Losses. Sigma Report No 1/2016. Zurich: Swiss Re.
730 http://media.swissre.com/documents/sigma1_2016_en.pdf.
731
732 Thaler, T., and Hartmann, T. 2016. Justice and flood risk management: reflecting on different
733 approaches to distribute and allocate flood risk management in Europe, *Natural Hazards.*
734 83(1): 129-147.
735
736 Thaler, T. A., Priest, S.J., and Fuchs, S. 2016. Evolving inter-regional co-operation in flood risk
737 management: distances and types of partnership approaches in Austria." *Regional*
738 *Environmental Change* 16(3): 841-853.
739
740 UNECE (United Nations Economic Commission for Europe). 2009. *Guidance on Water and*
741 *Adaptation to Climate Change.* Geneva: United Nations.

742
743 UNECE (United Nations Economic Commission for Europe). 2011. Second Assessment of
744 Transboundary Rivers, Lakes and Groundwaters. New York and Geneva: UNECE.
745
746 UNEP (United Nations Environment Programme). 2011. Enhanced Coordination Across the
747 United Nations System, Including the Environment Management Group. Twenty-Sixth
748 Session. UNEP/GC.26/15.
749
750 UNISDR (United Nations Institute for Disaster Reduction). 2015. Sendai Framework for
751 Disaster Risk Reduction: 2015-2030. Geneva: UNISDR.
752
753 Venturini G. (2012) International Disaster Response Law in Relation to Other Branches of
754 International Law. In: de Guttry A., Gestri M., Venturini G. (eds) International Disaster
755 Response Law. T.M.C. Asser Press, The Hague, The Netherlands.
756
757
758