



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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12 13 Abstract

14
15 This article examines the policy and institutional frameworks for response to ~~and~~ man-made
16 disasters occurring in the Danube basin and the Tisza sub-basin. Response to these types of
17 incidents has historically been managed separately, as has the monitoring of these types of
18 incidents. Given policy distinctions in response to natural and man-made disasters, we discuss
19 whether the distinctions remain functional given recent international trends toward holistic
20 response to both natural and man-made disasters. We suggest that these distinctions are
21 counterproductive, outdated, and ultimately flawed and conclude with a reflection of the lessons
22 learned, and propose an integrated framework in the Danube basin and Tisza sub-basin.

23
24 **Keywords:** International Disaster Response Frameworks; Natural Disasters; Man-made
25 Accidents; Industrial Accidents; Natech Accidents; Danube River basin; Tisza River Sub-basin



40 **1 Introduction**

41 What are the benefits of maintaining the distinction between natural and man-made
42 disasters? What are the consequences of eliminating this distinction? When a disaster occurs,
43 local and national capacities can be overwhelmed, often triggering a request for external,
44 international assistance. The actors engaged in disaster response have historically been
45 determined by the nature of the disaster (i.e., industrial accidents, nuclear accidents, marine oil
46 spills); but with growing recognition that anthropogenic climate change is driving more extreme,
47 and sometimes cascading events (e.g., where the effects of disasters are multiplied, or where they
48 are composite, or concurrent) that require complex and often overlapping types of response, the
49 question of eliminating this dichotomy is brought to the forefront.

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

55 In 2000, the Baia Mare and Baia Borsa mine-tailing pond failures mobilized
56 approximately 100,000 m³ of metal-contaminated water into the Tisza River, eventually
57 polluting the Danube River and Black Sea. Since the industrial accidents occurred originally as a
58 result of significant rainfall and flooding, these events are an example of what are commonly
59 referred to as natech accidents, technological accidents triggered by natural disasters. In 2010, an
60 industrial accident occurred in the Hungarian portion of the Danube River when a dam
61 containing alkaline red sludge collapsed, releasing 1.5 million m³ of sludge into the surrounding
62 land (approximately 4000 hectares) and waterways (including Kolontár, Torna Creek, and the



63 Danube River), killing 10 people and injuring several hundred more (ICPDR, 2010). In 2014,
64 following Cyclone Tamara, over 1,000 landslide events occurred in Serbia as well as significant
65 flooding, resulting in damage to properties and infrastructure and the inundation of agricultural
66 land. Due to concern over possible breaches in infrastructure to mine tailing dams in the
67 surrounding area, and the harmful effects to human health, technical experts investigated mining
68 sites and provided recommendations for local evacuations (NERC, 2014). In all three disasters,
69 the need for disaster response exceeded the capacity of national actors; therefore, international
70 response involved the United Nations, the European Commission, and various other international
71 organizations.

72 While international humanitarian law is generally well defined, the law of international
73 disaster response is still incomplete (Fisher, 2008). Historically, a distinction has been drawn
74 between the scope of natural disasters and man-made disasters; however, this distinction is
75 absent from the 2015 Sendai Framework for Disaster Risk Reduction, which adopts a multi-
76 hazard risk approach providing management tools for disasters that are both natural and man-
77 made (UNISDR, 2015). The European Union's disaster response framework is also holistic and
78 includes natural and man-made disasters, and some multilateral sub-regional agreements are also
79 taking similar approaches, such as those adopted by the Association of South East Asian Nations
80 (ASEAN) and the Baltic Sea Economic Cooperation (BSEC).

81 With international policies starting to shift toward more holistic frameworks of response
82 that incorporate both natural and man-made disasters, this article explores what this trend will
83 mean for regional institutions in the Danube basin and Tisza sub-basin, whose policy
84 frameworks for monitoring and response continue to distinguish between types of disasters.



85 This article begins with an overview of the study area and a description of the methodology.
86 Next is a discussion of the distinctions between natural disasters and industrial accidents – how
87 and why they have been treated differently and how recent developments in international law and
88 practice are raising questions about the merits of these distinctions. It is followed by an
89 examination of the international frameworks governing disaster response in the Danube basin
90 and Tisza sub-basin. Subsequently, the differences in how natural disasters and industrial
91 accidents are monitored, and how they are responded to, are explored. The article discusses the
92 transition of international policies toward more holistic frameworks for response, and concludes
93 with a reflection of how this might affect the Danube basin and Tisza sub-basin.

94 **2 Overview of study area and methodology**

95 The Danube River basin covers more than 800,000 km² – over 10 percent of continental
96 Europe – and flows through the territories of 19 countries with nearly 80 million people residing
97 within the basin. Today, 14 of the 19 countries, plus the EU, have committed to transboundary
98 cooperation in protecting the Danube via the Danube River Protection Convention (DRPC), and
99 work jointly toward the sustainable management of the Danube basin and the implementation of
100 both the European Union's Water Framework Directive (WFD) and Floods Directive (EU FD)
101 (ICPDR 2015a). Among the tributaries of the Danube River, the Tisza sub-basin has the largest
102 catchment area, and covers approximately 160,000 km² (20 percent of the Danube basin's area),
103 with approximately 14 million people (Fig. 1). There exists a distinct socio-economic contrast in
104 the basin between western and former socialist countries, and since the end of communism in the
105 late 1980s, the central and lower Danube has experienced a rapid shift to free market democracy
106 within the context of increased globalization, privatization, and deregulation. This has led to
107 rural decline as well as increased poverty, unemployment, and depopulation (WWF, 2003).



108 Additionally, as a result of the continuing conflict in Syria and neighboring states, countries in
 109 the Danube and throughout Europe are experiencing a significant increase in population from
 110 refugees, displaced persons, and other migrants who are escaping persecution, conflict, and
 111 poverty, and are settling in empty buildings, hotels, or refugee camps that have become ad hoc
 112 shelters (UNHCR, 2016)



Fig. 1 Map of Danube River basin and Tisza River sub-basin.

115 The headwaters of the Danube are located in the Black Forest of Germany. After leaving
 116 the Black Forest, the Danube flows generally south-east through Central and Eastern Europe to
 117 the Black Sea in eastern Romania (Fig. 1; ICPDR, 2009a). International measures regulating the
 118 Danube were first undertaken in 1882 for flood protection and navigation. Dams were
 119 constructed within the upper Danube basin for flood mitigation, hydroelectric power generation,



120 and regulation of river levels for navigation. The operation of these dams for these services has
121 been attributed with altering the flow regime of this segment of river and consequently varying
122 the ecological disturbance regime within the river and on the floodplain resulting is substantial
123 changes in the riverine ecosystem. The flow regulation provided by the dams and the
124 construction of levees has allowed for the conversion of floodplains and riverine wetlands into
125 area suitable for agricultural and urban development. Today only 12 small reaches (<1 km in
126 length) of the Upper Danube relatively remain untransformed (Schneider, 2010). In the Middle
127 and Lower Danube, the river bed has been dredged repeatedly to maintain a navigable river
128 channel. Along these segments of the Danube River, levees and dams mitigate or prevent
129 inundation of over 72 percent of the floodplain. The substantial reduction is Danube's connection
130 with its floodplain combined with wastewater discharge from agricultural and industrial sources,
131 and increasing levels of pollutants along these river segments have substantially altered or
132 damaged riverine ecosystem and reduced resiliency of urban and rural communities to large
133 floods which exceed the protection level of their flood mitigation measures (Schneider, 2010;
134 UNECE, 2011). The degree of industrial development and amount of pollution created by the
135 industrial sector varies among Danube countries. In general, pulp and paper industries represent
136 the largest contributors of pollution, followed by chemical, textile, and food industries (ICPDR
137 2009a).

138 The Tisza headwaters are located in the Carpathian Mountains in Ukraine. From these
139 headwaters the Tisza River flows southwest across central portions of the great Hungarian Plain
140 into the Danube River in Serbia (Fig. 1; ICPDR, 2008a). Precipitation within the Tisza basin is
141 generally concentrated in the Carpathian mountains within the upper portion of the watershed.
142 The intensity of the rainfall and the steep terrain coupled with deforestation and channelization



143 of many streams within this portion of the Tisza watershed, results in some of the most sudden
144 and high-energy flooding in Europe. Flood levels along the upper reaches of the Tisza can range
145 up to 12 m deep within as little as 24-36 hours (Nagy et al., 2010). The sudden water level rises
146 coupled with the high energy of the flows often threaten human lives and result in substantial
147 damage to infrastructure and croplands (ICPDR, 2008a).

148 While industrial production has dropped drastically in the Tisza since the 1990s, there
149 remain a variety of industries that contribute to the economy of the region, and the legacy of
150 heavily concentrated industrial activities continues to threaten the surrounding ecosystems. The
151 main industrial regions of the Tisza are located in Romania and Hungary, where the potential for
152 greatest flood damage and losses is also greatest. Chemical and petrochemical industries
153 (including oil refinery, storage and transport) are important for both Hungary and Ukraine, and
154 the cellulose and paper, textile, and furniture industries are also present predominantly in the
155 upper portion of the Tisza in Slovakia, Romania, and Ukraine (ICPDR, 2011). Beyond the threat
156 of mobilizing hazardous materials from industrial activities directly into the Danube or Tisza
157 Rivers, the risks posed from industrial accidents to the surrounding communities, particularly
158 with increasing urbanization, is of growing concern.

159 Mining activities, and the accidental spills of chemical substances, have affected the
160 aquatic environment and water quality within the Tisza sub-basin since the 2000 Baia Mare and
161 Baia Borsa natech accident. Natech accidents present significant challenges, as natural events
162 can trigger multiple and simultaneous accidents in one installation, or depending on the impact
163 of the natural hazard, in several hazardous facilities at the same time (Krausmann and Baranzini,
164 2012). A 2009 assessment identified more than 92 potential sources for industrial and waste
165 deposits; however, the list does not include abandoned mine sites and their mine tailing dams –



166 only those from currently operational mines¹ therefore, the potential risk of accidental pollution
167 could be substantially higher (ICPDR, 2015a).

168 **2.1 Methodology**

169 The analysis of policy and institutional frameworks for monitoring and responding to²
170 natural disasters and man-made accidents in the Danube River basin and Tisza River sub-basin
171 was conducted through a combination of primary and secondary data collection and analysis.
172 The primary data collection and analysis consisted of semi-structured interviews, while the
173 secondary data analysis included literature review of peer-reviewed publications and an analysis
174 of international laws, policies, and institutions within the Danube basin and Tisza sub-basin.
175 Semi-structured interviews were conducted over an eight-month period from January to August
176 2013.

177 Seventy-one interviews were conducted in various locations throughout Europe. The
178 interviews took place with experts working within the International Commission for the
179 Protection of the Danube River, within the expert groups of the International Commission for the
180 Protection of the Danube River (i.e., Tisza group, river basin management, flood protection, and
181 accident prevention and control), with respondents working at the national ministries, water
182 management directorates, and non-governmental organizations in the Tisza and Danube
183 countries, as well as with experts working within the European Commission, and the United
184 Nations involved in the Danube basin and Tisza sub-basin. Given public roles, the interviews are
185 intentionally left anonymous to ensure candidness in the responses (Table 1).³ The numbers
186 appearing in brackets in the table below reflect multiple interviews conducted at each level of
187 governance indicated. The questions focused on how Danube basin and Tisza sub-basin policies
188 and laws were implemented in practice, as well as the perceptions of the experts regarding the



189 frameworks and implementation of disaster monitoring and response throughout the Danube
 190 basin and Tisza sub-basin.¹

191 **Table 1.** Organizations from which experts were drawn for interviews.

		192
International	United Nations, United Nations Economic Commission for	193
	Europe, and United Nations Environment Programme	194
	(UNEP)/UN Office for the Coordination of Humanitarian	195
	Affairs (OCHA) Joint Environment Unit [1]	196
Regional	European Commission [2]	197
	International Commission for the Protection of the Danube	198
	River (ICPDR) and Expert Groups (Tisza Group, River Basin	199
	Management, Flood Protection, and Accident Prevention	200
National	and Control) [3]	201
	National Ministries of Environment, Rural Development,	202
	Interior, Environment Agency [4]	203
	Water Directorates [5]	204
Non-State Actors	NGOs [6]	205
		206

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

208 209 **3 Distinctions between natural disasters and man-made accidents in policy frameworks**

210
 211 Traditionally, the approaches used for describing, limiting, and categorizing disasters
 212 fundamentally shapes the methods for monitoring and responding to disasters. They determine
 213 the solutions utilized, the resources allocated, and the governance frameworks selected by
 214 categorizing the types of disaster into that which is natural or man-made. It is therefore important
 215 to understand the etiology of disaster in order to understand why the distinctions among the
 216 various types of disaster still remain. These are discussed below.

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 218
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 220

¹ 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?



221 **3.1 Rationale for different treatment**

222
 223 The manner in which disasters are framed by society has evolved over time, still the role
 224 of human responsibility features prominently in disaster narratives. Natural disasters are
 225 naturally occurring physical phenomena, which can include earthquakes, landslides, tsunamis,
 226 volcanoes and floods. Natural disasters have historically been characterized either (1) as a direct
 227 form of punishment from God for the sins of humanity, or (2) more recently as an “act of God”
 228 that removed humans from culpability (Rozario, 2007). The framing of natural disasters
 229 continues to shift, and some natural events – earthquakes, hurricanes, tsunamis – only become
 230 disasters as they impact and interact with individuals and communities. The consequences of
 231 natural disasters become a function of where people reside – along coastlines, in floodplains, in
 232 vicinity of fault lines, and within mountainous regions – and their overall vulnerability, including
 233 aging infrastructure and a function of their ability to monitor and prepare for these events,
 234 Vulnerability within and between populations can vary, and occur for multiple reasons – social
 235 inequalities, community demographics (e.g., age and poverty), lack of access to health care, and
 236 limited access to jobs or to lifelines (e.g., emergency response, goods, services) (Cutter and
 237 Emrich, 2006). While building in disaster-prone areas is not the sole responsibility of
 238 individuals, they do share responsibility for investing in the risk involved, the existence of moral
 239 hazard² can increase the amount of damage from disaster and reduce the capacity of insurance to
 240 cover disaster loss; this occurs due to individuals acting irresponsibly and because of those who
 241 erroneously believe there is coverage for any loss incurred (Smith, 2013). For example, offering

² For purposes of this paper and described by Munich Re (2007), moral hazard is a lack of incentive by an individual to guard or protect against risk (or to enter into a situation of risk), knowing that they are protected from risk through insurance, which results in higher insurance loss claims. Examples provided are assured compensation for flood damage, leading to increased building in flood-prone areas and assured compensation for crop losses in drought-prone areas that encourage farmers to grow more compensated crops instead of planting alternative crops or adopting alternative land uses.



insurance encourages people to build and live in flood-prone areas, in spite of the known risks – if insurance were not available, the household would absorb the entirety of the risk and prospective buyers would most likely choose to reside elsewhere. Additionally, as seen with some large disasters such as Hurricane Katrina, losses suffered by policyholders can be several times larger than collected premiums, consuming insurers' capital and, if the losses are severe enough, not only jeopardize claim payments, but also cause insurance companies to declare bankruptcy before covering any – or only some – insured losses (Nekoul and Drexler, 2016). For example, while the total economic loss incurred during Hurricane Katrina is assessed at approximately US\$ 125 billion, insured losses covered an estimated US\$ 45 billion, however, only an estimated US\$ 2 million in insurance claims were paid (Munich Re, 2005). Moral hazard can also exist in disaster preparedness and response activities when actors believe they are sufficiently prepared to respond to any event or crises. During Hurricane Katrina despite emergency preparations, preexisting social vulnerabilities and the collective failure to adequately respond to the emergency made response inadequate for the type of complex emergency relief needed (Cutter and Emrich, 2006).

Industrial accidents and other man-made accidents are traditionally considered separately from natural disasters. The role of human agency features even more prominently in these events, due to potential moral or legal obligations to mitigate risk (e.g., preparedness, insurance, disaster aid). Man-made disasters suggest potential moral and legal obligations to both aid the victims of the disaster in a response capacity in the period immediately following the disaster, as well as to compensate those who are harmed during their long-term recovery (Verchick, 2012). The liability is only effective if a polluter can be identified or liability can be assigned. As disasters continue to multiply, become more complex, and their costs mount, responsibility for



265 the disaster also becomes more complex. For example, in assigning liability to the 2010 red
266 sludge spill in Hungary, early reports from the Hungarian Prime Minister Victor Orbán indicated
267 that the breach was likely due to human error, and that “there was no sign the disaster was
268 caused by natural causes, therefore it must be caused by people” (Dunai, 2010). In ongoing
269 efforts to determine human negligence, it was determined that flooding and subsidence led to
270 structural breaches in the reservoir containing the alumina, yet it remained difficult to prove
271 whether officials at the MAL alumina facility knew of the weakened infrastructure (NDGDM,
272 2010).

273 The degree of uncertainty related to the amount of damage and probability of occurrence
274 is very high with disasters, particularly those influenced by climate change (Greiving et al.,
275 2012; Munich Re, 2016). Liability can be more difficult to calculate and assign in these cases, in
276 part because disaster loss agencies (i.e., Munich Re, Swiss Re), are often accounting for specific
277 losses from flooding and sudden-onset disasters that are more easily quantified, whereas the
278 impact of slow-onset, or “silent”, disasters related to climate change can be more difficult to
279 quantify since they occur slowly over time (IFRC, 2013).

280 **3.2 Dimensions for different treatment**

281 Increased frequency of major disasters, legal barriers and the absence of response to
282 natural disasters and man-made accidents have led to increased attention at a variety of levels for
283 more integrated international frameworks for disaster response (IFRC, 2007). The fragmented
284 nature of disaster response has emerged from the need to address specific types of disasters, in
285 specific regions, or response modalities. Furthermore, while natural disasters and industrial and
286 nuclear accidents have established frameworks for response, natech accidents are often missing
287 from chemical accident response programs (OECD, 2015). Natech accidents can lead to the
288



289 release of toxic substances, fires, or explosions, and result in injuries and fatalities; therefore, the
290 lack of consideration for natech response mechanisms, planning tools or response programs can
291 be an external risk source for chemical facilities (Krausmann and Baranzini, 2012). Some
292 international instruments, such as the Convention on Assistance in the Case of a Nuclear
293 Accident or Radiological Emergency and the Convention on Early Notification of a Nuclear
294 Accident apply only to specific types of disaster. While the Nuclear Accidents Conventions were
295 adopted almost immediately following the Chernobyl nuclear accident, there still remains no
296 similar overarching global framework for notification or assistance in response to industrial
297 accidents, or for environmental emergencies more broadly (Bruch et al., 2016). Other disaster
298 frameworks, like the Tampere Convention, apply only to a single sector or area of relief (such as
299 importing telecommunication resources following disasters caused by nature or human activity,
300 or whether occurring suddenly or as the result of complex, long-term processes). However, the
301 ability to provide disaster response for natural disasters is quite broad and is included in a
302 number of international frameworks. A question of applicability of agreements arises, however,
303 when a complex disaster occurs and multiple institutions have a mandate for response, but it is
304 unclear which institution should take the lead in responding or coordinating response efforts
305 (Bruch et al., 2016). During the Lebanon crisis in 2006, international assistance was requested in
306 response to the bombing of fuel storage tanks at a power station, and over 70 countries and
307 organizations responded – it was unclear who should take lead, and the need for coordination
308 was reflected among response efforts (Nijenhuis, 2014).

309 An additional difficulty lies in the types of international actors engaged in natural
310 disasters and man-made accident response. Generally, there is a failure to include non-state
311 actors, the private sector, or individuals in response efforts to disasters. The Tampere Convention



312 and the sub-regional Black Sea Economic Cooperation (BSEC) and Association of South East
313 Asian Nations (ASEAN) agreements are exceptions. With the Tampere Convention, for example,
314 the decision to offer assistance, the type of assistance provided, and the terms of assistance are
315 up to the discretion of the non-state actors offering assistance (Bruch et al., 2016). Given the
316 increasing role of private funds in disaster response and relief operations, considering the
317 inclusion of these actors in disaster frameworks can be beneficial. Oftentimes, there is the
318 assumption that assets and personnel are provided as a favor to an affected state government,
319 where they might normally be expected to reimburse costs and manage how assistance is carried
320 out. However, efforts are increasingly being made to clarify the respective roles of actors and
321 institutions in regard to disaster response, and more recently laws are changing in favor of
322 including broader terminology to comprise both natural and man-made disasters (IFRC, 2007).

323 **4 Disaster frameworks in the Danube and Tisza**


324 Response to natural and man-made disasters, including natech accidents, is governed by a
325 range of global, regional and national laws, policies and soft-law instruments. In the Danube
326 basin and Tisza sub-basin this includes the Industrial Accidents Convention and the Seveso
327 Directive, the Water Framework Directive and the Floods Directive, as well as treaties and
328 policies developed at the level of the Danube and Tisza. Here, natural and man-made disasters
329 continue to be treated as distinct and separate issues, where monitoring and response are
330 managed independently.

331 **4.1 Introduction to Danube and Tisza**

332 In 1994 the Danube countries developed the Danube River Protection Convention
333 (DRPC) to ensure sustainable management of the Danube River. Through the International
334 Commission for the Protection of the Danube River (ICPDR), the DRPC requested the ICPDR to



335 coordinate the activities of the EU Water Framework Directive (WFD) and EU Floods Directive
336 among the EU member states. The WFD combines the monitoring and assessment of surface and
337 groundwater quality in the basin, and the Floods Directive instructs national authorities to
338 establish flood risk management plans by 2015, linking the objectives of the WFD and the risk to
339 these objectives from flooding or coastal erosion through the Floods Directive, and integrating
340 them into basin level activities via the ICPDR. However, because not all countries of the Danube
341 are EU member states, not all measures and outcomes of the WFD and Floods Directive are
342 implemented equally among the basin countries.

343 The Danube basin and the Tisza sub-basin have experienced numerous natural and man-
344 made disasters, including natech accidents (e.g., Baia Mare Cyanide Spill, Hungarian Chemical
345 Accident, and recent Serbian landslides,  these are tallied in Table 2. However, the frameworks
346 for disaster response at the levels of the United Nations, the European Union, and those utilized
347 by the ICPDR and implemented at the national level by the Danube countries, are restricted to
348 particular types of disaster – monitoring and response to flooding is the most advanced
349 throughout the basin, while pollution is monitored, but does not have the same frameworks for
350 response. Additionally, there remain a variety of natural and man-made disasters that occur
351 throughout the basin that are not integrated into any type of basin monitoring or response
352 framework, including fire, drought, and other types of predictive climate modeling.

353 **Table 2.** Natural and man-made disasters in the Danube basin, reported by country (2000-
2012). (Adapted from European Commission, 2016.)

Year	Type of Event	Country
2000	Mine tailing failure/cyanide and heavy metal pollution (natech)	Romania, Hungary, Bulgaria, Macedonia
	Landslide/avalanche	Austria, Slovenia
	Extreme temp./drought	Bulgaria, Croatia, Slovenia
	Flooding	Croatia, Hungary, Romania, Slovenia
	Severe ice storms	Moldova, Ukraine
	Wildfires	Croatia, Slovakia





2001	Factory fire	Slovenia
	Mining accident (natech)	Slovenia
	Flooding	Croatia, Hungary, Romania, Slovakia, Ukraine
2002	Industrial fire at waste dump	Slovenia
2003	Mining accident (natech)	Slovenia
	Extreme temp./drought	Austria, Croatia, Germany, Slovenia, Bosnia and Herzegovina
2004	Flash floods/severe storms	Hungary
	Wildfires	Slovenia
	Drinking water pollution (natech)	Hungary
	Dam failure	Romania
	Earthquake	Slovenia
	Flooding/severe storms	Hungary, Slovakia
2005	Drought	Bosnia and Herzegovina
	Landslides	Slovenia
	Flooding/Severe Storms	All Danube Countries, except Ukraine
2006	Avian (H5N1) flu pandemic	Hungary, Romania, Slovenia
	Aircraft accident	Hungary
	Earthquake	Hungary
	Extreme Temp.	Bulgaria
	Wildfires	Slovenia
2007	Wildfires/forest fires	Bulgaria, Croatia
	Hurricane	Germany
	Extreme temp./drought	Austria, Bulgaria, Croatia, Hungary, Romania, Slovakia, Bosnia and Herzegovina, Montenegro, Serbia, Moldova
		Bulgaria, Germany, Hungary, Romania, Slovenia, Montenegro, Serbia, Ukraine
	Flash floods/severe storms	
2008	Transportation accident	Croatia
	Extreme temp.	Bulgaria
	Forest fires	Bulgaria
	Flash floods/severe storms	Hungary
	Flooding	Romania, Slovakia, Slovenia, Serbia, Moldova, Ukraine
2009	Swine (H1N1) flu pandemic	All Danube Countries
	Ice storms/blizzard	Croatia, Romania, Bosnia and Herzegovina, Ukraine
2010	Chemical accident (natech)	Hungary
	Earthquake	Serbia
2012	Ice storms/blizzards	Bulgaria, Hungary, Romania, Montenegro, Serbia, Moldova, Ukraine
	Extreme temp./drought	Moldova

354 -Note that economic losses, deaths and displacements are not reported to either European Commission or ICPDR.



355 4.2 How disasters are treated differently within response frameworks

356 In the absence of a centralized institution for disaster response, the development of a
357 large and diverse international disaster relief community has occurred. Initially the large-scale
358 relief work after natural disasters was undertaken by the Red Cross movement at the end of the
359 19th century, but eventually the disaster relief community expanded capacity and function to
360 include a variety of disaster assistance activities and involve other international initiatives and
361 organizations (IFRC, 2007). The United Nations (UN) began humanitarian work shortly after
362 World War II with agencies such as the United Nations High Commission for Refugees
363 (UNHCR), and predecessor agencies such as the United Nations Office for the Coordination of
364 Humanitarian Affairs (UN OCHA) are now regularly engaged in disaster response and relief
365 (IFRC, 2007).

366 Numerous frameworks for response to natural disasters exist. One example is the 2002
367 UN General Assembly Resolution 57/150 on “Strengthening Effectiveness and Coordination of
368 Urban Search and Rescue Assistance” (UN, 2003). While non-binding, the resolution highlights
369 the importance of national responsibility to victims of natural disasters within country borders,
370 but in the event that an incident exceeds country capacity, Urban Search and Rescue (USAR)
371 assistance through the International Search and Rescue Advisory Group (INSARAG) can
372 supplement local rescuers, and the coordination of these resources, particularly following
373 earthquakes or other events leading to structural collapse (INSARAG, 2016).

374 Apart from natural disasters, the United Nations Economic Commission for Europe’s
375 (UNECE) Industrial Accident Convention applies to land-based, non-military, and non-
376 radiological industrial accidents (UNECE, 2009). Through the convention, response for
377 industrial accidents is provided through bilateral or multilateral arrangements developed in



378 advance among the parties. If no prior agreements exist, an affected country can request
 379 assistance from other parties through mutual assistance agreements. However, in these situations,
 380 it is the responsibility of the requesting country to cover all costs incurred for disaster response,
 381 unless otherwise agreed upon among the responding countries (UNECE, 2009). Flooding in the
 382 Danube in 2013 and 2014 caused approximately €15 billion in damage (Table 3), and while the
 383 economic cost from industrial and other man-made accidents are not monitored or reported in the
 384 same manner (Table 2), such accidents have occurred quite frequently and make apparent the
 385 need for improved agreements on bilateral or multilateral relief (ICPDR 2015b).

386 **Table 3.** Estimated human and economic loss in Danube per flood event
 (2002-2014) (Adapted from ICPDR, 2008b and ICPDR, 2015b).

Flood Year	# Deaths or # Displaced	Economic Losses €
2002	N/A	N/A
2006	N/A	> €6 billion
2010	35 deaths	€2 billion
2013	9 deaths	€2.4 billion
2014	79 deaths; 137,000 displaced	€4 billion

387 *N/A – Data not available

388 The facilitation of international disaster response can be inadequate if mobilization is
 389 untimely, or fails to include sufficient financial support. Response frameworks may neglect or
 390 place disproportionate attention on certain types of disasters, which could become more
 391 problematic with growing concerns over climate change and increased urbanization. For
 392 example, there is visible delayed response for sudden-onset disasters such as the 2005 Indian
 393 Ocean tsunami and the 2010 Haiti earthquake which received the majority of funding support
 394 within one to three months of the initial request, compared to the slow-onset drought events of
 395 the 2011 appeals by Kenya and Somalia where funding was not provided until nearly 7-12
 396 months after the initial request (GHA, 2013). In 2005, nearly three quarters of all UN
 397 contributions for natural disasters arrived within a month of their appeal; the comparable figure
 398 for complex emergencies was only seven percent (IFRC, 2007). While differences exist among



399 slow-onset and sudden-onset disasters, they can create cumulative impacts to the community that
400 increase vulnerability and lead to larger disasters in the future – precipitation deficiencies in soil
401 and water lead to drought and when combined with high temperatures and dry conditions, this
402 can lead to wildfires (e.g., extreme fire hazard situations in the eastern US and south-east
403 Australia) (Smith, 2013).

404 The growing size and diversity of international responders to disasters can have
405 ramifications for the facilitation, coordination, and quality of response efforts (IFRC, 2007).
406 Diverse systems of response are implemented among the Danube basin countries due to the
407 variety of disasters experienced. Some utilize a single Civil Protection Mechanism, while others
408 rely on multiple parties among Ministries of the Interior, Ministries of Rural Development,
409 Water Directorates, and a variety of additional local protection committees [4, 5]. Interviews
410 indicated that not all responders/parties are sufficiently trained, and many lack managerial or
411 technical capacity to manage specific disasters appropriately [4]. There is also large
412 compartmentalization of tasks at lower levels – both regional and local – where integration
413 among the various types of disaster, as well as increased cooperation is needed [2, 3]. Other than
414 the fact that these diverse actors are providing certain types of disaster assistance, there is
415 nothing uniting them – no international or regional disaster response system. Given the increased
416 frequency of natural and man-made disasters and the growing number of actors involved in
417 disaster response efforts, ensuring effectiveness of aid should not detract from response and
418 assistance (IFRC, 2007).

419 Besides the diverse ensemble of international organizations with a mandate and capacity
420 for responding to natural disasters and/or specific types of technological or industrial accidents,
421 there are also agencies experienced in particular types of international disasters, but which may



422 not necessarily have the mandate or capacity for response. In 1994, the United Nations
423 Environment Programme (UNEP) and the UN Department of Humanitarian Affairs (DHA, the
424 predecessor of OCHA), developed an administrative arrangement through an exchange of letters
425 (Bruch et al., 2016). The arrangement relies on the environmental mandates of UNEP and the
426 humanitarian mandates of the DHA. Through UNEP's Governing Council Decision
427 UNEP/GC.26/15 on "Strengthening International Cooperation on the Environmental Aspects of
428 Emergency Response and Preparedness", the Joint UNEP/UN OCHA Environment Unit (JEU)
429 plays a leading role in facilitating coordination among international organizations in the event of
430 natural and man-made disasters, including natech accidents, which are more broadly termed
431 environmental emergencies (UNEP, 2011). The JEU has a number of existing agreements and
432 interface procedures in place with these organizations, in order to facilitate response, particularly
433 because there is a lack of familiarity among UN member states regarding existing regional and
434 international systems for response to the various types of disasters, as well as the coordination
435 between them. For example, the JEU facilitated international agreements and interface
436 procedures to aid with response between UN Disaster Assessment and Coordination (UNDAC)
437 and the EU Civil Protection Mechanism to the 2014 Serbian landslides following Cyclone
438 Tamara (NERC, 2014). During the 2000 Baia Mare natech accident in the Tisza River sub-basin,
439 sixteen experts from seven countries deployed for response to the natech accident, and the JEU
440 assisted to coordinate response efforts among UNDAC, the European Commission, the Military
441 Civil Defence Unit, the World Health Organization, and a variety of other actors (JEU, 2000).

442 At the regional level, the European Union's Civil Protection Mechanism (EU CPM) is an
443 instrument for disaster response that protects people, the environment, property, and cultural
444 heritage in the event of natural or man-made disasters, occurring within or outside of the



445 European Community (European Commission, 2016). Disasters are monitored internationally
446 through the Emergency Response Coordination Centre (ERCC) in cooperation with the JEU and
447 with participating states.

448 The European Union's Seveso Directives (I enacted in 1982, II enacted in 1996, and III
449 enacted in 2012) are some of the earliest pieces of legislation to address disaster risk (European
450 Community, 1982; European Community, 1996; European Community, 2012). The various
451 iterations of the Directive govern the establishments where dangerous substances are present,
452 and require the establishments to classify and report the amounts, types, and locations of
453 dangerous substances present. The majority of the Directives' focus is on notification
454 requirements and accident prevention, including notification to the public due to the increased
455 risk by natural disasters associated with the location of the establishment and associated risks
456 from natech accidents (European Union, 2012). The responsibility for response under the
457 Directives falls on the establishment for developing preparedness response measures in advance
458 of an accident, and notifying the competent authority in case of a major accident (European
459 Union, 2012). However, a 2012 study by the European Commission indicated that industry in
460 nearly half of the EU countries is believed to insufficiently consider natech risks in their
461 preparedness response measures (Krausmann and Baranzini, 2012).

462 The EU Floods Directive provides a framework for addressing risk from natural disasters,
463 specifically floods. While inspired not only by the damaging effects of floods, but also by
464 increasing flood risks as a result of climate change, the main objective of the Directive is to
465 require member states to assess and manage risks of flooding within their territories and to
466 develop flood risk management plans. Though the plans are restricted to areas considered at high
467 risk of floods, these are not integrated into other types of plans and maps available – such as the



468 Inventory of Potential Accidental Risk Spots in the Danube³ – nor are they used for developing
469 preparedness response measures in advance of an accident or natural disaster, such as in the case
470 of the Seveso Directive. Though the Flood Directive was expected to reduce flood risk,
471 interviewees voiced disappointment regarding the limitations of integrating disaster risk more
472 broadly, particularly in relation to water quality and accidental pollution [3]. These present as
473 policy limitations to the Water Framework Directive and Flood Directive, as neither of the two
474 directives require the integration of disaster risk of both floods and accidental pollution.

475 The European Union also developed a set of macro-regional strategies for the Adriatic
476 and Ionian, Alpine, Baltic Sea, and Danube regions (European Commission, 2010). While the
477 intent from the EU was to not provide new EU funding, these integrated frameworks are
478 supported by EU Structural and Investment Funds in order to address common challenges faced
479 in each defined area in order to strengthen cooperation and achieve greater economic, social, and
480 territorial cohesion. In the Danube Strategy, risks from floods and industrial accidents are
481 reflected as having substantially negative transnational impacts, and are listed as requiring
482 preventive and disaster management measures that are implemented jointly, with the
483 understanding that work undertaken in isolation in one place (e.g., to build levees) displaces the
484 problem and places neighboring regions at greater risk of flooding (European Commission,
485 2010). Other man-made disasters are integrated in the discussion of risks, as well as the need to
486 account for climate change by taking a regional focus at the basin level (European Commission,
487 2010, p. 8). In a 2015 European Commission Communication report following implementation
488 of the Danube Strategy, several limitations were highlighted, including: the need to improve

³ Pursuant to the 2001 Baia Mare natech accident in Romania, the ICPDR conducted a qualitative evaluation of the hazardous locations in the Danube catchment area, with reference to location of possible water pollution. The report of Inventory of Potential Accidental Risk Spots was released in 2001, and has not been updated since (ICPDR, 2001; ICPDR, 2015a).



489 efforts to reduce the Danube region's risk of exposure to major floods and accidental hazardous
490 material releases; limited political commitment, funding, and capacity among countries and
491 institutions in the Danube; lack of staff, funding, and expertise impeding participation,
492 particularly in lesser-developed areas of Danube – the report also acknowledged that these
493 challenges are more acute in non-EU countries (EPRS, 2015). The limitations in funding,
494 technical expertise, and capacity were confirmed in interviews with experts at various levels,
495 who also noted how this leads to uneven implementation of EU Directives within the basin that
496 can create pockets of vulnerability to both flood risk and risks from industrial accidents [2, 3, 4].

497 While the Danube Strategy does not provide a framework for response to natural and
498 man-made disasters, it does highlight the EU's continued support for managing multi-hazard
499 response at multiple levels, particularly through Priority Area 5 "To Manage Environmental
500 Risks". Specifically, it requests that the countries "strengthen operational cooperation among
501 emergency response authorities in the Danube countries and improve the interoperability for
502 risks that are common to an important number of countries in the region (i.e., floods and risks of
503 other natural and man-made disasters)", and advises that each country's civil protection
504 mechanism have an updated understanding of neighboring country's systems so that response
505 teams can function smoothly in case of emergencies involving bilateral, European, or
506 international response (EUSDR, 2015). Experts also expressed the need for formal agreements
507 with specific language on integrated mapping of complex disasters, as well as provisions
508 addressing response to both natural and man-made disasters, particularly if additional grants
509 could be given from the EU to support these activities [2, 3, 4, 5]. Some interviewees reflected
510 that the regional Strategy depended on stronger countries helping the weaker ones, but
511 limitations with funding and capacity are difficult to overcome [2]. In the 2015 Annual Report on



512 implementation of the Danube Strategy produced by the Danube countries, all projects focused
513 on implementation of the Floods Directive. The only mention of industrial accidents was to
514 reflect the failure to include an updated Inventory of Potential Accidental Risk Spots along the
515 Danube, which is also discussed in the 2015 Danube River Basin Management Plan (DRBMP)
516 (EUSDR, 2015; ICPDR, 2015b). Given past issues with mine tailing collapses and other
517 pollution disasters associated with flooding, the 2015 DRBMP acknowledged the need to update
518 the Inventory of Potential Accidental Risk Spots promptly (ICPDR, 2015b). Unfortunately, this
519 recommendation from the 2015 DRBMP, and initially expressed in first Danube River Basin
520 Management Plan of 2009 has yet to be realized.

521 Through the Danube River Protection Convention, Article 17 provides for mutual
522 assistance “where a critical situation of riverine conditions should arise”. While “critical
523 situation” is not defined, Article 17 indicates that the ICPDR will elaborate procedures for
524 mutual assistance including, the facilities and services to be rendered by the contracting party,
525 the facilitation of border-crossing formalities, arrangements for compensation, and methods of
526 reimbursement (ICPDR, 1994). These elaborations have not occurred through the ICPDR, but
527 rather in the form of bilateral agreements regarding transboundary flood measures among
528 Danube countries; however virtually no bilateral agreements exist regarding response to man-
529 made disasters in the basin (Table 4).

530 **Table 4.** Bilateral agreements on transboundary watercourses and disasters among Danube
countries (Adapted from ICPDR, 2009a; ICPDR, 2015a; UNEP, 2002).

Countries	Transboundary Watercourses	Disasters / Emergencies
Austria – Czech Republic	1967**	1994 (Floods Only)
Austria – Germany	1987	1991 (Floods Only)
Austria – Hungary	1956	1959 (Floods Only)
Austria – Slovakia	1967**	1994 (Floods Only)
Austria – Slovenia	1956*	1956* (Floods Only)



Bosnia and Herzegovina – Croatia	1996	1996 (Natural/Manmade Disasters)
Bosnia and Herzegovina – Serbia and Montenegro*	-	2011 (Flood EWS)
Bulgaria – Romania	2004	2004 (Floods Only)
Bulgaria – Serbia	Draft	Draft (Floods Only)
Croatia – Hungary	1994	1994 (Floods Only)
Croatia – Serbia	-	-
Croatia – Slovenia	No Date	1977*** (Coastal Pollution)
Czech Republic – Slovakia	1999	-
Hungary – Romania	1986	2003 (Floods Only)
Hungary – Slovakia	1956**	2014 (Floods Only)
Hungary – Slovenia	1994	1994 (Floods Only)
Hungary – Ukraine	1997	1998 (Floods Only)
Moldova – Romania	2010	2010 (Floods Only)
Moldova – Ukraine	1994	-
Serbia and Montenegro – Hungary	1955*	1955*
Serbia and Montenegro – Romania	1955*	Under Discussion
Ukraine – Romania	1997	1952*** (Floods Only)
Ukraine – Slovakia	1995	2000 (Floods Only)

*Agreement formed with Yugoslavia

**Agreement formed with Czechoslovak Socialist Republic

***Agreement formed with Union of Soviet Socialist Republics

- No Information Available

To bridge the gap regarding man-made accidents, some Danube basin countries have engaged in such agreements. Bulgaria, Moldova, Romania, Serbia, and Ukraine are Parties to the DRPC, but have separately engaged in the BSEC Agreement on Response to Natural and Man-made disasters (Bruch et al., 2016). Furthermore, the Danube Delta countries (Moldova, Romania, and Ukraine) are working together with the UNECE Industrial Accidents Convention due to the large concentration of oil-related industries in the area in order to improve hazard management, increase transboundary cooperation, and strengthen operational response [1].



543 At the Danube basin level, the countries have engaged in a series of non-binding
544 Memoranda of Understanding (MOU) referred to as the Danube Declarations, first in 2004,
545 revised in 2010, and updated in 2016. The Declarations reinforce the language of the 1996
546 Danube River Protection Convention to sustainably manage the waters of the Danube, and
547 reinforce the countries' commitment to continue the work of the WFD and Floods Directive. The
548 2016 Declaration recognizes the need for increased investment and improved warning systems
549 for flood protection and contamination, as well as improving the exchange of information
550 throughout the Danube (ICPDR, 2016). The Danube River basin countries engage currently in
551 two separate systems for flood monitoring and monitoring pollution from man-made accidents –
552 the Emergency Flood Alert System and the Principal International Alert Centres (PIACs) of the
553 Danube Accident Emergency Warning System (Danube AEWS), respectively. The Emergency
554 Flood Alert System has been functioning since 2003 at the Joint Research Centre, a Directorate
555 General of the European Commission, and works in collaboration with the national authorities of
556 the member states and with a variety of meteorological services. The Emergency Flood Alert
557 System provides two medium-range flood forecasts each day, with 3-10 day advance warning for
558 flooding in the main stem of the Danube. An MOU has been signed with several, but not all of
559 the Danube countries (Austria, Bulgaria, Czech Republic, Germany, Hungary, Moldova, Serbia,
560 Slovakia, Slovenia, and Romania, and negotiations are underway with Bosnia and Herzegovina
561 and Croatia), and information is available 24 hours a day through an online service managed by
562 the Joint Research Centre (ICPDR, 2010). The Emergency Flood Alert System gives national
563 authorities the ability to prepare response measures, including opening temporary flood retention
564 areas, building temporary flood protection structures such as sandbag walls, and adopting civil
565 protection measures such as closing down water supply systems (ICPDR, 2009b). These



566 responses reduce further threat of flooding downstream, and prevent loss of lives and
567 infrastructure. The MOU does not include tributaries draining areas less than 4,000 km²,
568 therefore the Emergency Flood Alert System does not address flood risks in the Tisza, nor in
569 certain basin countries where significant flood concerns arise, such as Ukraine [1].
570 Transboundary floods typically affect larger areas, can be more severe, result in a higher number
571 of deaths, and cause increased economic loss than non-transboundary rivers (Baaker, 2009).
572 Therefore, the repeated occurrence of such large, costly flood events (Table 3) highlights the
573 ongoing need for improved strategies for flood preparedness and response, particularly in the
574 absence of coordinated, multi-hazard bilateral and multilateral agreements among basin
575 countries.

576 The Principle International Alert Centres of the Danube Accident Emergency Warning
577 System monitor accidental water pollution incidents in the Danube River basin. Unlike the
578 Emergency Flood Alert System, which is linked to monitoring conducted by the European
579 Commission and is transmitted to national authorities (without involving the ICPDR in the
580 monitoring process); the Danube AEWS system is managed by the ICPDR, but does not involve
581 the European Commission. While all contracting parties of the DRPC cooperate with the Danube
582 AEWS, they also are expected to have national policies regarding response to accidental
583 pollution in the Danube that connects to the Principle International Alert Centres. The PIACs are
584 expected to operate on a 24-hour basis within each country, and are in charge of all international
585 communications. When a message regarding potentially serious accidental pollution occurs, the
586 PIAC is responsible for communicating the accident to the ICPDR, and decides whether it is
587 necessary to notify downstream countries, engages experts to assess the impacts of the pollution,
588 and decides what response activities need to be taken at the national level (ICPDR, 2014).



589 Challenges to the Danube AEWS monitoring include territorial gaps (several areas along the
590 Danube and Tisza are not monitored) [3, 4, 5], a limited number of bilateral agreements for
591 response in case the accident exceeds national capacity (Table 4), and even though a variety of
592 natural and man-made accidents occur (Table 2), not all types of man-made accidents are
593 monitored. Increasing pressures are felt by downstream countries from the failure to monitor
594 pollution events in a consistent and effective manner [4]. Furthermore, in order to keep the
595 AEWS operational there is increasing reliance on citizen reporting of pollution events in some
596 countries [4, 5]. This is particularly problematic in the Tisza countries where the lack of
597 monitoring of both flood and accidental pollution events, combined with limited bilateral
598 agreements raise concern among several countries [4, 5].

599 In the most recent Tisza River sub-basin MOU (from 2011), the Tisza countries agreed,
600 among other things, to “take coordinated steps to prevent accidental risks, and develop
601 harmonized mitigation and response measures, with the aim to present an updated Inventory of
602 Potential Accidental Risk Spots by the end of 2012” (ICPDR, 2011). This complements the 2009
603 request in the Danube basin (but as reflected above, has yet to be updated) (ICPDR, 2015b). To
604 date, this has not occurred for the Tisza sub-basin, but the language in the MOU does reflect an
605 interest at the sub-basin level to prioritize not only the mapping and development of an Inventory
606 of Potential Accidental Risk Spots, but also the development of harmonized response measures
607 among floods and man-made hazards.

608 **5 Questioning the distinction**

609 While “natural” disasters may be a commonly used term, no disaster can be regarded as
610 entirely natural if people have the capacity to avoid, mitigate, or reduce the risk from an entirely
611 natural hazard (Picard, 2016). However, the vulnerability to lives and livelihoods can be avoided
612



613 with proper disaster preparedness and response, such as the proper placement, function, and use
614 of early warning systems, flood maintenance, and mitigation works such as levees and controlled
615 flood outlets and properly timed dam releases.

616 There is an additional shift in what is considered truly a natural disaster as well – not only
617 from the perspective of mitigation or vulnerability, but in acknowledgement of the anthropogenic
618 influences on natural disasters. Climate change is one aspect, but there are also induced
619 earthquakes occurring as a result of slipping faults from fluid injection in hydraulic fracturing
620 (Legere, 2016) and from the weight of shifting water impoundments from Three Gorges (Stone,
621 2008), landslides from subsidence and increased land use activities including urbanization
622 (Smith, 2013), and pandemics from deforestation and habitat conversion (Greger, 2007), to name
623 a few. Holistic frameworks that include multiple types of disasters are needed in order to respond
624 effectively.

625 Human intervention in the physical environment exposes populations to natural hazards
626 from the built environment, such as housing and associated infrastructure, including industrial
627 facilities, drainage works, and planning—especially when the built environment is not
628 appropriately designed or built to account for the risks. Human, economic, and environmental
629 losses can be worse in highly populated, urbanized areas; with increased urbanization and
630 climate change, they are placed at increased risk to natural and man-made hazards (Bruch and
631 Goldman, 2012; Huppert and Sparks, 2006). For this reason, natech accidents and other
632 cascading disasters are particularly problematic types of disasters. Simultaneous response efforts
633 are required to attend to both the industrial, chemical, or technological accident as well as the
634 triggering natural disaster. Therefore, broad definitions of disaster, as well as broad frameworks
635 for response to multiple types of disaster are needed in order to recognize that many disasters can



636 arise from multiple hazards—and to take the necessary measures to reduce the risks of those
637 hazards.

638 While distinctions among disasters are still claimed for liability in some cases (including
639 in determining deliberate conduct or negligence), the distinction between natural and man-made
640 disasters is largely irrelevant from the perspective of humanitarian response and the humanitarian
641 consequence of multi-hazard events and those that are caused by natural or technological
642 hazards. Furthermore, in the event that disasters are slow-onset, or when the ability to mitigate or
643 respond to risk is not timely or effective, the long-term effects of the disaster can be magnified
644 and lead to further vulnerability, such as famine, malnutrition, or mortality (IFRC, 2006).

645 The 2011 Fukushima nuclear disaster in Japan, triggered by the Great East Japan
646 Earthquake and resultant tsunami, illustrated the complex relationship of natural hazards and the
647 built environment and human factors, resulting in natech vulnerabilities. In part as a response to
648 the earthquake, tsunami, and nuclear accident at Fukushima and as a more general approach to
649 providing a comprehensive, multidimensional and multi-sectoral approach to reducing disaster
650 risk, the United Nations member states adopted the Sendai Framework for Disaster Risk
651 Reduction in 2015. To some experts, the preceding 2005 Hyogo Framework for Action focused
652 too much on disaster risk reduction from natural disasters, and ignored industrial accidents and
653 complex accidents like natech accidents [6]. In fact, in a 2011 study by the European
654 Commission, out of 14 EU countries that experienced natech accidents, more than half of the
655 accidents resulted in the release of toxic substances, fires, or explosions (Krausmann and
656 Baranzini, 2012).

657 The Sendai Framework places unprecedented emphasis on the interaction between
658 hazards (natural and man-made), exposure levels, and pre-existing vulnerability (Aitsi-Selmi and



659 Murray, 2016). It calls to action for improving decision making through a stronger science-
660 policy-practice interface, with four priority areas for action –including strengthening disaster
661 governance with regard to shared resources and at the basin level (UNISDR, 2015).

662 The Organization for Economic Cooperation and Development (OECD) also provides
663 guidance for the planning and operation of facilities where hazardous substances are located
664 through the use of their 2003 Guiding Principles for Chemical Accident Prevention,
665 Preparedness, and Response. Recognizing the gaps in natech risk management and
666 methodologies, the OECD developed an addendum in 2015 to the Guiding Principles that
667 include 1) an investigation of the prevention of chemical accidents, as well as preparedness for
668 and response to chemical accidents resulting from natural hazards that are not a part of national
669 chemical accident programs; and 2) recommendations for best practices with respect to
670 prevention of, preparedness for, and response to natech accidents (OECD, 2015).

671 Regional frameworks for response to natural and man-made disasters have been
672 developed by member states of the Black Sea Economic Cooperation (BSEC) and the
673 Association of South East Asian Nations (ASEAN). These regional agreements have also
674 progressed to include national efforts, such as the coordination of technical assistance and
675 resource mobilization during response to natural and man-made disasters (ASEAN, 2010; BSEC,
676 1998).

677 **6 Building holistic approaches for integrating multilevel disaster response**

678 The transition toward a multi-hazard approach for response to natural and man-made
679 disasters, and the acknowledgement of the risks of natech accidents is occurring at many levels.
680 It is present in the work of the United Nations and the multilevel response frameworks of the EU
681 Civil Protection Mechanism; some regional agencies are also adopting similar agreements (i.e.,



682 ASEAN, BSEC). However, there remains a disparity in managing natural and man-made
683 disasters in a holistic manner at the national level, as well as in the monitoring of these types of
684 events at the Danube basin and Tisza sub-basin levels. The challenges are not insurmountable;
685 this section proposes two sets of options for reducing and eventually eliminating the historic
686 dichotomy among approaches to disaster response and monitoring.

687 **6.1 Multi-hazard approaches**

688 The process of building holistic approaches to planning, preparedness, and response can
689 strengthen systems for responding to natural and man-made disasters in a more integrated
690 manner. Building holistic disaster risk management processes may be done at the global (e.g.,
691 Sendai), regional (e.g., BSEC), bilateral, and national levels.

692 The review of legal and policy frameworks and interviews reflected that while some
693 planning and preparedness activities take place regarding flood hazard, this generally is not the
694 case for accidental pollution (at least in the Danube and Tisza context), and natech accidents are
695 largely removed or ignored [2, 3, 4, 5, 6] (European Commission, 2010; ICPDR, 2015a). Gaps in
696 monitoring were cited along the length of both the Danube and the Tisza in regard to both
697 flooding and accidental pollution, which should also be improved in future planning efforts. The
698 Tisza sub-basin and smaller water bodies are beyond the scope of the WFD, consequently, no
699 holistic monitoring or response measures are in place; regional agreements at the basin or sub-
700 basin level could aid in developing improved response frameworks [2, 3] (McClain et al., 2016).

701 Improving the mapping of hazards to reflect not only flood hazard, but also risks from
702 man-made disasters and natech events – and integrating these risks into a holistic map of
703 vulnerability to disaster – would provide a foundation for more holistic policies and
704 programming to manage disaster risks. It would also aid in improving measures for preparedness



705 at the national and local levels. Multi-hazard response frameworks provide the opportunity to
706 intervene and mitigate the size of future disasters. Interviews indicate that harmonized
707 approaches to natural and man-made disasters offer additional opportunities to strengthen
708 capacity among transboundary actors [1, 4].

709 **6.2 Multi-hazard response modalities**

710 In order to empower, guide, and facilitate the institutional arrangements and mandates
711 necessary to improve monitoring of and response to natural and man-made disasters, the legal
712 and policy frameworks need to provide the necessary mandates and procedures. In regard to the
713 Danube basin, this could be done in a variety of ways. The Danube River Protection Convention
714 has not been updated or amended since it was originally drafted in 1994, but it unites all
715 countries of the Danube basin and its tributaries under a formal, legal agreement. Cooperation
716 among Danube countries was generally reported as good [3]; therefore, continuing the use of the
717 ICPDR and its expert groups as a mechanism to gain cooperation among the countries on a
718 regional framework for improving monitoring and response could be considered [3, 4, 5].
719 Another possibility would be to expand the numerous bilateral agreements among the Danube
720 and Tisza countries regarding flooding to also include man-made disasters and natech events.
721 Working on agreements at a regional level improves communication, breaks down barriers
722 (particularly in transboundary situations), and aids in the development of a common legal
723 language among participating parties [1, 2].

724 Updating conventions and other hard law can be difficult; countries often find soft law to
725 be more flexible, they are sometimes unwilling to adopt binding obligations, particularly in the
726 face of uncertainty (e.g., climate change), or when they feel there might be a need to act quickly
727 to changing circumstances. In this regard, updating the Danube Declaration and the



728 corresponding Tisza MOUs can provide particularly viable options. Through the Declarations
729 and MOUs, the Danube or Tisza countries could decide whether to engage in a particular action
730 through a separate strategy, or pilot project, or whether to incorporate the issue into the broader
731 basin or sub-basin management plan (e.g., improvement of accidental pollution and flood
732 monitoring, integrated accidental pollution and flood maps). Improved vertical and horizontal
733 cooperation was a request of several interviewees, particularly in regard to the risks posed from
734 man-made accidents and how to respond to these accidents [4, 5].

735 **7 Conclusions**

736
737 The historic distinction between natural and man-made disasters is outdated,
738 counterproductive, and ultimately flawed. Natural disasters have the potential to trigger
739 simultaneous technological or chemical accidents from one or multiple sources. With
740 anthropogenic climate change influencing the frequency and intensity of disasters, the
741 distinctions in preventing, monitoring, and responding to disasters from either natural or man-
742 made sources are further called into question. Moreover, increased urbanization and shifting
743 populations are placing more people at greater risk in times of disaster (whether natural or man-
744 made). As a result, it is increasingly clear that there are no purely natural disasters.

745 Recognizing that the historic distinctions between natural and man-made disasters are no
746 longer relevant, there is increasing recognition of the need to address disasters holistically,
747 regardless of the contributing causes and aggravating factors. This trend is noted in the Sendai
748 Framework, which adopts a multi-hazard risk approach and provides tools for managing
749 disasters that are both natural and man-made (UNISDR, 2015). While the current policy
750 frameworks in the Danube basin and Tisza sub-basin do not address preparedness and response
751 holistically across types of disasters, the basin countries have several options for more integrated



752 response. A key opportunity is the development or amendment of agreements governing
753 response to natural and man-made disasters. This could be negotiated through updates to the
754 Danube Convention or through bilateral treaties between the basin countries. Improving planning
755 and preparedness through more integrated monitoring and mapping of natural and man-made
756 disasters, such as combining the flood risk areas with the Inventory of Potential Accidental Risk
757 Spots, could be elaborated upon in Declarations and MOUs at the basin and sub-basin levels.

758 A coordinated approach to natural and man-made disasters, including natech accidents, is
759 currently taken through the European Union Civil Protection Mechanism and BSEC. This is not
760 unique to Europe alone, and other similar regional approaches exist from which to draw lessons
761 (including the ASEAN agreement). The Danube and Tisza countries are well versed in the
762 transboundary impacts from natural and man-made disasters, and natech accidents; climate
763 change is likely to increase the frequency and severity of these events in the foreseeable future.
764 Nevertheless, while approaches for integrating holistic frameworks for disaster response are
765 recognized at multiple levels, implementation within the Danube basin and Tisza sub-basin
766 remains distinct and fragmented.

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776 References

- 777
 778 Aitsi-Selmi, A., and Murray, V. 2016. The Chernobyl Disaster and Beyond: Implications of the
 779 Sendai Framework for Disaster Risk Reduction 2015-2030. *PLOS Medicine* 13(4): 1-4.
 780
 781 ASEAN (Association of South East Asian Nations). 2010. ASEAN Agreement on Disaster
 782 Management and Emergency Response: Work Programme 2010-2015. Jakarta: ASEAN.
 783 [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)
 784 [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)
 785 [%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).
 786
 787 Baaker, M.H.N. 2009. Transboundary River Floods: Examining Countries, International River
 788 Basins, and Continents. *Water Policy* 11: 269-288.
 789
 790 BSEC (Black Sea Economic Cooperation). 1998. Agreement among the Governments of the
 791 Participating States of the Black Sea Economic Cooperation (BSEC) on Collaboration in
 792 Emergency Assistance and Emergency Response to Natural and Man-Made Disasters.
 793 [http://www.bsec-](http://www.bsec-organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf)
 794 [organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergen](http://www.bsec-organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf)
 795 [cyagreement%20071116.pdf](http://www.bsec-organization.org/documents/LegalDocuments/agreementmous/agr4/Documents/Emergencyagreement%20071116.pdf).
 796
 797 Bruch, C., Nijenhuis, R., and McClain, S.N. 2016. International Frameworks Governing
 798 Environmental Emergency Preparedness and Response: An Assessment of Approaches.
 799 In *The Role of International Environmental Law in Reducing Disaster Risk*, Jacqueline
 800 Peel & David Fisher eds. Leiden: Brill Nijhoff.
 801
 802 Cutter, S.L., and Emrich, C.T. 2006. Moral Hazard, Social Catastrophe: The Changing Face of
 803 Vulnerability along the Hurricane Coasts. *American Academy of Political and Social*
 804 *Science* 604:102-112.
 805
 806 Dunai, M. 2010. Hungary Declares Emergency after Red Sludge Spill. *Reuters*, October 5.
 807 <http://in.reuters.com/article/idINIndia-51952420101005>.
 808
 809 European Commission. 2010. Communication from the Commission to the European Parliament,
 810 the Council, the European Economic and Social Committee, and the Committee of the
 811 Regions: European Strategy for the Danube Region. COM (2010) 715 Final.
 812
 813 European Commission. 2016. EU Civil Protection Mechanism. 2 July.
 814 http://ec.europa.eu/echo/what/civil-protection/mechanism_en.
 815



- 816 European Community. 1982. Council Directive of 24 June 1982 on the Major-Accident Hazards
 817 of Certain Industrial Activities. Official Journal of the European Communities L230, pp.
 818 01-18.
 819
- 820 European Community. 1996. Council Directive of 9 December 1996 on the Control of Major-
 821 Accident Hazards Involving Dangerous Substances. Official Journal of the European
 822 Union. L010, pp. 13.
 823
- 824 European Community. 2012. Council Directive of 4 July 2012 on the Control of Major-Accident
 825 Hazards Involving Dangerous Substances, Amending and Subsequently Repealing
 826 Council Directive 96/82/EC. Official Journal of the European Union L197, pp. 01-37.
 827
- 828 European Union. 2012. Directive 2012/18/EU of the European Parliament and of the Council of
 829 4 July 2012 on the Control of Major-Accident Hazards Involving Dangerous Substances,
 830 Amending and Subsequently Repealing Council Directive 96/82/EC. Official Journal of
 831 the European Union L197, pp. 01-37.
 832
- 833 EPRS (European Parliamentary Research Service). 2015. The EU Strategy for the Danube
 834 Region: Briefing. PE 557.024.
 835 [http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557024/EPRS_BRI\(2015\)55](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557024/EPRS_BRI(2015)557024_EN.pdf)
 836 [7024_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557024/EPRS_BRI(2015)557024_EN.pdf).
 837
- 838 EUSDR (European Union Strategy for the Danube Region). 2015. Danube Region Strategy
 839 Priority Area 5: To Manage Environmental Risks. Coordinated by Hungary and
 840 Romania. June.
 841
- 842 Fisher, D. 2008. The Law of International Disaster Response: Overview and Ramifications.
 843 *International Law Studies* 83: 293-320.
 844
- 845 GHA (Global Humanitarian Assistance). Global Humanitarian Assistance Report. Bristol: GHA.
 846
- 847 Greger, M. 2007. The Human/Animal Interface: Emergence and Resurgence of Zoonotic
 848 Infectious Diseases. *Critical Reviews in Microbiology* 33: 243-299.
 849
- 850 Grieving, S., Pratzler –Wanczura, S. Sapountzaki, K., Ferri, F., Grifoni, P., Firus, K., and
 851 Xanthopoulos, G. 2012. Linking the actors and policies throughout the management cycle
 852 by “Agreement on Objectives” – a new output-oriented approach. *Natural Hazards and*
 853 *Earth Systems Sciences* 12: 1085-1107.
 854
- 855 Huppert, H.E., and Sparks, R.S.J. 2007. Extreme Natural Hazards: Population Growth,
 856 Globalization and Environmental Change. *Philosophical Transactions of the Royal*
 857 *Society* 364: 1875-1888.
 858
- 859 ICPDR (International Commission for the Protection of the Danube River). 1994. Danube River
 860 Protection Convention. Vienna: ICPDR.
 861 <https://www.icpdr.org/main/sites/default/files/DRPC%20English%20ver.pdf>.



- 862
863 ICPDR (International Commission for the Protection of the Danube River). 2001. Inventory of
864 Potential Accidental Risk Spots. Vienna: ICPDR.
865
866 ICPDR (International Commission for the Protection of the Danube River). 2008a. Analysis of
867 the Tisza River Basin 2007. Vienna: ICPDR.
868 http://www.icpdr.org/main/sites/default/files/Tisza_RB_Analysis_2007.pdf.
869
870 ICPDR (International Commission for the Protection of the Danube River). 2008b. The Analysis
871 of the Danube Floods 2006. Vienna: ICPDR.
872 [https://www.icpdr.org/main/sites/default/files/The%20Analysis%20of%20the%20Danub](https://www.icpdr.org/main/sites/default/files/The%20Analysis%20of%20the%20Danube%20Floods%202006%20FINAL.pdf)
873 [e%20Floods%202006%20FINAL.pdf](https://www.icpdr.org/main/sites/default/files/The%20Analysis%20of%20the%20Danube%20Floods%202006%20FINAL.pdf)
874
875 ICPDR (International Commission for the Protection of the Danube River). 2009a. The Danube
876 River Basin District Management Plan: Part A- Basin-wide Overview. Vienna: ICPDR.
877 http://www.icpdr.org/main/sites/default/files/DRBM_Plan_2009.pdf.
878
879 ICPDR (International Commission for the Protection of the Danube River). 2009b. Assessment
880 of Flood Monitoring and Forecasting in the Danube River Basin. Vienna: ICPDR.
881 [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)
882 [%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).
883
884 ICPDR (International Commission for the Protection of the Danube River). 2010. New
885 International System for Early Flood Warning in Danube River Basin Launched. March.
886 [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)
887 [pdr.pdf](https://www.icpdr.org/main/sites/default/files/nodes/documents/080310_efas_pr_final_icpdr.pdf).
888
889 ICPDR (International Commission for the Protection of the Danube River). 2011. Memorandum
890 of Understanding: Towards the Implementation of the Integrated Tisza River Basin
891 Management Plan Supporting the Sustainable Development of the Region. Vienna:
892 ICPDR.
893
894 ICPDR (International Commission for the Protection of the Danube River). 2014. International
895 Operations Manual for PIACs of the Danube AEWS. Vienna: ICPDR.
896 [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)
897 [pdf](http://www.icpdr.org/main/sites/default/files/nodes/documents/aews_manual_2014_final.pdf).
898
899 ICPDR (International Commission for the Protection of the Danube River). 2015a. The Danube
900 River Basin District Management Plan – Update 2015. Vienna: ICPDR.
901 <https://www.icpdr.org/main/sites/default/files/nodes/documents/dr bmp-update2015.pdf>.
902
903 ICPDR (International Commission for the Protection of the Danube River). 2015b. Flood Risk
904 Management Plan for the Danube River Basin District. Vienna: ICPDR.
905 https://www.icpdr.org/main/sites/default/files/nodes/documents/1stdfrmp-final_1.pdf.
906



- 907 ICPDR (International Commission for the Protection of the Danube River). 2016. Danube
908 Declaration: Water Management in the Danube River Basin: Integration and Solidarity in
909 the Most International River Basin of the World. Vienna: ICPDR.
910
- 911 IFRC (International Federation of Red Cross and Red Crescent Societies). 2006. World Disasters
912 Report: Focus on Neglected Crises. Geneva: ATAR Roto Presse.
913
- 914 IFRC (International Federation of Red Cross and Red Crescent Societies). 2007. Law and Legal
915 Issues in International Disaster Response: A Desk Study. Geneva: IFRC.
916
- 917 IFRC (International Federation of Red Cross and Red Crescent Societies). 2013. Responding to
918 Silent Disasters. IFRC Annual Report. Geneva: IFRC.
919
- 920 INSARAG (International Search and Rescue Advisory Group). 2016. United Nations General
921 Assembly Resolution. Accessed 17 June. [http://www.insarag.org/en/about/ga-](http://www.insarag.org/en/about/ga-resolution.html)
922 [resolution.html](http://www.insarag.org/en/about/ga-resolution.html).
923
- 924 JEU (Joint United Nations Environment Programme (UNEP)/Office for the Coordination of
925 Humanitarian Affairs (OCHA) Environment Unit). 2000. Cyanide Spill at Baia Mare
926 Romania: Spill of Liquid and Suspended Waste at the Aurul S.A. Retreatment Plant.
927 Geneva: OCHA.
928
- 929 Krausmann, E., and Baranzini, D. 2012. Natech Risk Reduction in the European Union. *Journal*
930 *of Risk Research* 15(8): 1027-1047.
931
- 932 Legere, L. 2016. State Seismic Network Helps Tell Fracking Quakes from Natural Ones.
933 *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)
934 [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)
935 [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).
936
- 937 Linnerooth-Bayer, J., Eckenberg, L. and Vári, A. 2013. Catastrophe Models and Policy
938 Processes: Managing Flood Risk in the Hungarian Tisza River Basin – An Introduction.
939 In *Integrated Catastrophe Risk Modeling: Supporting Policy Processes*, A. Amendola et
940 al. Eds., 171-179. Dordrecht: Springer Science.
941
- 942 McClain, S.N., Bruch, C., and Secchi, S. 2016. Adaptation in the Tisza: Innovation and
943 Tribulation at the Sub-basin Level. *Water International* 0: 1-23.
944
- 945 Munich Re. 2005. Topics Geo Annual Review: Natural Catastrophes 2005. *Geo Risks Research*.
946 Munich: Munich Re Group.
947
- 948 Munich Re. 2016. Group Annual Report 2015. Munich: Munich Re.
949 [https://www.munichre.com/site/corporate/get/documents_E1695037882/mr/assetpool.sha](https://www.munichre.com/site/corporate/get/documents_E1695037882/mr/assetpool.shared/Documents/0_Corporate%20Website/_Financial%20Reports/2016/Annual%20Report%202015/302-08843_en.pdf)
950 [red/Documents/0_Corporate%20Website/_Financial%20Reports/2016/Annual%20Report](https://www.munichre.com/site/corporate/get/documents_E1695037882/mr/assetpool.shared/Documents/0_Corporate%20Website/_Financial%20Reports/2016/Annual%20Report%202015/302-08843_en.pdf)
951 [%202015/302-08843_en.pdf](https://www.munichre.com/site/corporate/get/documents_E1695037882/mr/assetpool.shared/Documents/0_Corporate%20Website/_Financial%20Reports/2016/Annual%20Report%202015/302-08843_en.pdf).
952



- 953 Nagy, I., Ligetvári, F., and Schweitzer, F. 2010. Tisza River Valley: Future Prospects.
954 *Hungarian Geographical Bulletin* 59(4): 361-370.
955
- 956 NDGDM (National Directorate General for Disaster Management). 2010. Red Sludge – Hungary
957 2010. Ministry of the Interior. Budapest: Ministry of the Interior.
958 [http://www.katasztrofavedelem.hu/index2.php?pageid=szervezet_red_sludge_2010&lang](http://www.katasztrofavedelem.hu/index2.php?pageid=szervezet_red_sludge_2010&lang=eng)
959 [=eng](http://www.katasztrofavedelem.hu/index2.php?pageid=szervezet_red_sludge_2010&lang=eng).
960
- 961 Nekoul, F.M., and Drexler, A. 2016. Do Insurers in Catastrophe-prone Regions Buy Enough
962 Reinsurance? *Chicago Fed Letter* No 360.
963 <https://www.chicagofed.org/~media/publications/chicago-fed-letter/2016/cfl360-pdf.pdf>.
964
- 965 NERC (Natural Environmental Research Council). 2014. UNDAC Landslide Advisory Visit to
966 Serbia June 2014. Open Report IR/14/043. P. Hobbs Ed. Keyworth: British Geological
967 Survey.
968
- 969 Nijenhuis, R. 2014. The International Environmental Emergencies Response System: A Case
970 Study of Supertyphoon Haiyan (Yolanda), the Philippines. *Asian Journal of Environment*
971 *and Disaster Management* 6(2): 175-190.
972
- 973 OECD (Organization for Economic Cooperation and Development). 2015. Addendum No. 2 to
974 the OECD Guiding Principles for Chemical Accident Prevention, Preparedness, and
975 Response (2nd Ed.) to Address Natural Hazards Triggering Technological Accidents
976 (Natechs).
977 [http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono\(2](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2015)1&doclanguage=en)
978 [015\)1&doclanguage=en](http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2015)1&doclanguage=en).
979
- 980 Picard, M. 2016. Water Treaty Regimes as a Vehicle for Cooperation to Reduce Water-Related
981 Disaster Risk: The Case of Southern Africa and the Zambesi Basin. In *The Role of*
982 *International Environmental Law in Reducing Disaster Risk*, Jacqueline Peel & David
983 Fisher eds. Leiden: Brill Nijhoff.
984
- 985 Rozario, K. 2007. The Culture of Calamity: Disaster & the Making of Modern America.
986 Chicago: University of Chicago Press.
987
- 988 Schneider, E. 2010. Floodplain Restoration of Large European Rivers, with Examples from the
989 Rhine and the Danube. In *Restoration of Lakes, Streams, Floodplains, and Bogs in*
990 *Europe: Principles and Case Studies*, 185–223. USA: Springer Science.
991
- 992 Schneller, K., Bálint, G. Chicos, A. Csete, M. Dzurdzenik, J. Göncz, A. Petrisor, A. Jaroslav, T.
993 and Pálvolgyi, T. 2013. Climate Change Impacts on the Hungarian, Romanian, and
994 Slovak Territories of the Tisza Catchment Area. In *European Climate Vulnerabilities and*
995 *Adaptation: A Spatial Planning Perspective*, P. Schmidt-Thomé and S. Greiving, Eds.,
996 205-229. New Jersey, USA: John Wiley & Sons, Ltd.
997



- 998 Smith, K. 2013. Environmental Hazards: Assessing Risk and Reducing Hazard. New York:
999 Routledge.
- 1000
- 1001 Stone, R. 2008. Three Gorges Dam: Into the Unknown. *Science* 321(5889): 628-632.
- 1002
- 1003 Swiss Re. 2016. Natural Catastrophes and Man-Made Disasters in 2015: Asia Suffers Substantial
1004 Losses. Sigma Report No 1/2016. Zurich: Swiss Re.
1005 http://media.swissre.com/documents/sigma1_2016_en.pdf.
- 1006
- 1007 UN (United Nations). 2003. Strengthening the Effectiveness and Coordination of International
1008 Urban Search and Rescue Assistance. Official Records of the General Assembly. Fifty-
1009 Seventh Session. A/RES/57/150.
- 1010
- 1011 UNECE (United Nations Economic Commission for Europe). 2009. Guidance on Water and
1012 Adaptation to Climate Change. Geneva: United Nations.
- 1013
- 1014 UNECE (United Nations Economic Commission for Europe). 2011. Second Assessment of
1015 Transboundary Rivers, Lakes and Groundwaters. New York and Geneva: UNECE.
- 1016
- 1017 UNEP (United Nations Environment Programme). 2002. Atlas of International Freshwater
1018 Agreements. Nairobi: UNEP.
- 1019
- 1020 UNEP (United Nations Environment Programme). 2011. Enhanced Coordination Across the
1021 United Nations System, Including the Environment Management Group. Twenty-Sixth
1022 Session. UNEP/GC.26/15.
- 1023
- 1024 UNHCR (United Nations High Commissioner for Refugees). 2016. UNHCR, Displacement and
1025 Disaster Risk Reduction. Geneva: UNHCR.
- 1026
- 1027 UNISDR (United Nations Institute for Disaster Reduction). 2015. Sendai Framework for
1028 Disaster Risk Reduction: 2015-2030. Geneva: UNISDR.
- 1029
- 1030 Verchick, R. 2012. Disaster Justice: The Geography of Human Capability. *Duke Environmental*
1031 *Law & Policy Forum* 23: 23-71.
- 1032
- 1033 WWF (World Wildlife Fund). 2003. Managing Rivers Wisely: Lessons from WWF's Work for
1034 Integrated River Basin Management. Introduction, Synthesis and Case Studies.
1035 Washington, DC: WWF.
1036 <http://d2ouvy59p0dg6k.cloudfront.net/downloads/mrwadanubecasestudy.pdf>.
- 1037
- 1038
- 1039
- 1040
- 1041
- 1042
- 1043