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1 **Storm surge resilience and the Sendai Framework: risk perception, intention to**
2 **prepare and enhanced collaboration along the German North Sea coast**

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6 **Abstract**

7 This work assesses the capacity of the German North Sea coast community, which has been hit
8 by several disastrous storm surge events in the past, to organise itself before, during, and after
9 storm surge events in order to minimise the impacts. By means of a survey-based method, we
10 explore stakeholders' perception regarding the risk and emergency management processes, the
11 psychological and social factors conditioning the intention to prepare and collaborate, as well as
12 the feasibility of enhanced coordination and collaboration mechanisms at the community level.
13 Acknowledging past and ongoing successful initiatives in the study area, the method allows
14 identifying opportunities to foster preparedness and adaptation, such as an improved risk
15 communication strategy, mainstreaming and integrating risk reduction within and across
16 sectors, and the transition from basic participatory approaches based solely on information
17 provision towards full involvement and collaborative approaches. The major findings of the
18 study represent an initial diagnostic to help meet the guidelines and priorities proposed in the
19 recent Sendai Framework for Disaster Risk Reduction 2015-2030.

20 **1. Introduction**

21 According to the guiding principles of the Sendai Framework for Disaster Risk Reduction 2015-
22 2030 (UN/ISDR, 2015), each state has the primary responsibility in the prevention and
23 reduction of disaster risk, in order to protect persons, properties, health, livelihoods, productive
24 assets, cultural and environmental goods, as well as human rights, including the right to
25 development. This document emphasizes the need to understand local specificities conditioning
26 the success of disaster risk reduction (DRR) measures although risk drivers may be local,
27 national or global in scope. The framework also highlights cooperation as crucial, conceptually
28 including (i) responsibility-sharing among authorities, sectors and stakeholders, (ii) an all-of-
29 society engagement and partnership with empowerment and inclusive participation, and (iii) the
30 development of international, regional, subregional and transboundary cooperation schemes.
31 Finally, it also reveals that encouraging pro-active private investments and public awareness
32 campaigns is more cost-effective than primary reliance on post-disaster re-active response and
33 recovery.

34 At the German North Sea coast, millions of people live and work in low-lying areas. Several
35 disastrous storm surge events have hit this coast in the past even causing loss of lives. These
36 impacts have to this day brought about a continuous improvement of coastal protection facilities
37 and the establishment of a governmental structure that deals with storm surge risk management,
38 reducing the impacts of contemporary events effectively and successfully. The need for an
39 improved DRR is therefore, not justified by an unsuccessful management but by an increased
40 risk in the future resulting from climate change. According to IPCC (2014), due to projected sea
41 level rise through the 21st century and beyond, coastal systems and low-lying areas will
42 increasingly experience adverse impacts such as submergence, coastal flooding, and coastal

43 erosion, which will be exacerbated by the intensifying effect on storm surge events (Gaslikova
44 et al., 2013; Weisse et al., 2014; Woht et al., 2006).

45 A community exposed to a hazard is considered resilient when able to resist, absorb,
46 accommodate to and recover from its effects in a timely and efficient manner (UN/ISDR, 2009).
47 The level at which that community is aware of the hazard, prepared for its impacts and able to
48 recover afterwards, is conditioned by institutional and social capacities as well as by the
49 availability of necessary resources. In this context, the objective of this work is to assess the
50 resilience of the German North Sea coastal community to cope with and recover from a
51 potential storm surge event, minimizing short-term impacts and fostering long-term adaptation.
52 To fulfil this objective, we have applied a conceptual framework and a survey-based method
53 presented in González-Riancho et al. (2015)¹. This framework allows exploring the
54 stakeholders' perception of risk and emergency management processes, as well as psychological
55 and social factors conditioning both the intention to prepare at the individual level, and the
56 feasibility of enhanced coordination and collaboration mechanisms at the community level.
57 Both the framework and method were applied in 2014 to a small pilot study area (85 km coastal
58 stretch) with a very small but representative sample of stakeholders (16) in order to validate the
59 approach as a potential tool to assess storm surge resilience. The validated method was then
60 applied in 2015 to the entire German North Sea coast. The main contribution of this current
61 work is the presentation of the outcomes for the German North Sea coast including the data,
62 conclusions and lessons learnt for societal adaptation to be used in the design of further DRR
63 measures in the area as well as for other hazardous coastal locations.

64 **2. A survey-based resilience assessment**

65 A general description of the resilience framework and method applied here is presented as an
66 introduction to the results; however, González-Riancho et al. (2015) provides further
67 information, such as the theoretical and methodological background.

68 The framework connects institutional, social and legal dimensions in disaster risk management
69 (DRM) to enhance community preparedness, emergency management and long-term adaptation.
70 The institutional adaptation relates to the implementation of the disaster management cycle in a
71 specific study area based on the existing regulations. Institutional performance will move
72 towards higher adaptation levels if the authorities are aware of the risk, have the technical
73 know-how to manage storm surge risks, and have official jurisdiction over the matter. Social
74 adaptation, however, does not depend on competences and regulations, but on the society's
75 values, risk cultures, perceptions and dynamics. Therefore, the voluntary change of behaviour
76 towards adaptation can only be assessed by understanding people's intentions and readiness to
77 adapt, assuming that intentions are the immediate antecedent of behaviour (Ajzen, 1991).
78 Another key point in social adaptation is the understanding of society's evolution from
79 individuality towards collectivism. In this regard, it is important to explore people's intentions
80 to collaborate for the common objective of risk reduction and adaptation, as well as the support
81 and empowerment mechanisms facilitated by the authorities to materialise the cooperation. This
82 is where social and institutional adaptation processes converge and call for a close collaboration
83 to reach an improved risk management.

¹ Work developed within the framework of the FP7 ENHANCE Project (Enhancing risk management partnerships for catastrophic natural disasters in Europe, www.enhanceproject.eu)

84 These concepts can be jointly assessed by exploring stakeholders' perceptions of risk and risk
 85 management procedures. A questionnaire has been designed for this purpose (Table 1). It is
 86 structured into 20 resilience criteria referring to three resilience themes: risk information and
 87 perceived institutional preparedness (I), individual and collective preparedness (II) and
 88 coordination mechanisms and economic/policy options (III). The first theme explores the
 89 perceptions on the current mitigation measures and emergency management, the availability of
 90 risk information and its consideration in the sectoral decision-making process. It allows
 91 highlighting the amount, coverage, quality and homogeneity of the information within reach of
 92 the different types of stakeholders. The second theme is based on the factors conditioning the
 93 stakeholder's individual intention to prepare, the currently undertaken preparation measures, the
 94 attitude towards participatory approaches and the level of community involvement. Finally, the
 95 third theme allows understanding the feasibility, social acceptance, expected degree of success
 96 and implementation challenges of several coordination mechanisms and policy options. All
 97 questions have been developed by the authors although some of them relate to resilience
 98 concepts presented in previous works such as Paton (2003, 2005, 2010), Becker et al. (2011,
 99 2013) and Birkmann et al. (2012). The questionnaire includes scoring (Likert-type scale),
 100 selection and open-ended questions. Since the questionnaire is comprehensive, i.e. 20 questions
 101 composed of various sub-questions, the scoring intervals and selection options have been varied
 102 to maintain the attention of the respondent.

103 **Table 1.** Structure and type of applied survey questions to assess the resilience to storm surge risk (20 resilience
 104 criteria to address 3 resilience themes, i.e. I. Risk information and perceived institutional preparedness; II. Sectoral
 105 and community preparedness; III. Coordination mechanisms and policy options). The last column shows the content-
 106 wise connection between the questionnaire and the UN/ISDR Sendai Framework Priorities (P1: Priority 1
 107 Understanding disaster risk; P2: Priority 2 Strengthening disaster risk governance; P3: Priority 3 Investing in disaster
 108 reduction; P4: Priority 4 Enhancing disaster preparedness for effective response).

| Resilience themes and criteria | Question to stakeholders' knowledge/perception/opinion | Type of question | Sendai Framework |
|--------------------------------|--|---|--|
| I. Expected impacts | <p>Q1. The expected impacts that could be generated in case of storm surge flooding.</p> <p>Q2. The availability of risk-related information provided by the responsible authorities.</p> <p>Q3. The extent to which the risk knowledge is considered in the sectoral decision-making.</p> <p>Q4. The effectiveness of the currently applied flood protection measures.</p> <p>Q5. The availability of preparedness and recovery options for flooding events.</p> <p>Q6. The type of warning currently being issued in case of a storm surge event.</p> <p>Q7. The responsible authorities for the various processes within storm surge risk management.</p> | Scores (1-5) Scores (1-3) Scores (1-3) Scores (1-5) Scores (1-4) Selection (different options) Selection (different options) | P1 P1, P4 P1, P2, P4 P4 P4 P4 |
| II. Critical awareness | <p>Q8. The main problems they worry about, as a predictor of intention to prepare.</p> <p>Q9. Their trust in institutions, mechanisms and structures related to risk management.</p> <p>Q10. Their experience with major storm surge flooding events.</p> <p>Q11. The risk perception regarding their sector and living/working activities.</p> <p>Q12. The level of involvement that their sector should have within risk management.</p> <p>Q13. Their current proactive/reactive behaviour and consideration thereof by the authorities.</p> <p>Q14. The accomplishment of preparation measures and the main constraints faced.</p> <p>Q15. The community participation and involvement within storm surge risk management.</p> | Selection (3 options) Scores (1-5) Selection (one option) Selection (different options) Selection (one option) Selection (one option) Selection (different options) Scores (1-5) | P1 P4 P1 P1 P2 P2 P3 P2 |

| | | | |
|--------------------------------------|---|------------------------|----|
| Active stakeholders | Q16. The stakeholders/persons currently having an active role in storm surge management within the community. | Open-ended | P2 |
| III. Partnerships structure | Q17. The involvement of specified stakeholders in a potential partnership for risk reduction. | Scores (1-3) | P2 |
| Partnerships benefits and challenges | Q18. The main benefits that a partnership could bring and the main foreseen difficulties to be faced. | Selection (3 options) | P2 |
| Partnerships suitability | Q19. The willingness to participate in such a partnership. | Selection (one option) | P2 |
| Economic and policy options | Q20. The adequacy of various potential economic instruments and policy options. | Scores (1-5) | P3 |

109 **3. Storm surge resilience on the German North Sea coast**

110 *3.1. Description of the study area*

111 The German North Sea coast is part of the Wadden Sea area, the largest and most important
112 marine wetland in Europe (Enemark, 2005). Its coherent tidal flat area incorporates the coast
113 from Den Helder (Netherlands) along the whole German North Sea coast to Esbjerg (Denmark).
114 The Wadden Sea area is mainly characterized by intertidal sand and mudflats, which are
115 periodically flooded during high water. Landwards, these areas move on to floodplains
116 (foreland), where there is less flooding than in the tidal flats. Due to an extensive coastal
117 protection system, the adjacent elements of salt marshes, representing the main landward
118 landscape elements, are almost completely cut off from the tidal range by dykes (Reise, 2005).
119 Furthermore, a barrier island system, situated in front of West (Netherlands), East and North
120 (Germany) Frisia, separating the Wadden Sea from the open North Sea, serves as a natural
121 buffer protecting the mainland against storm surges. Most of the barrier islands in the Wadden
122 Sea Region are inhabited and have been used for centuries (Oost et al., 2012).

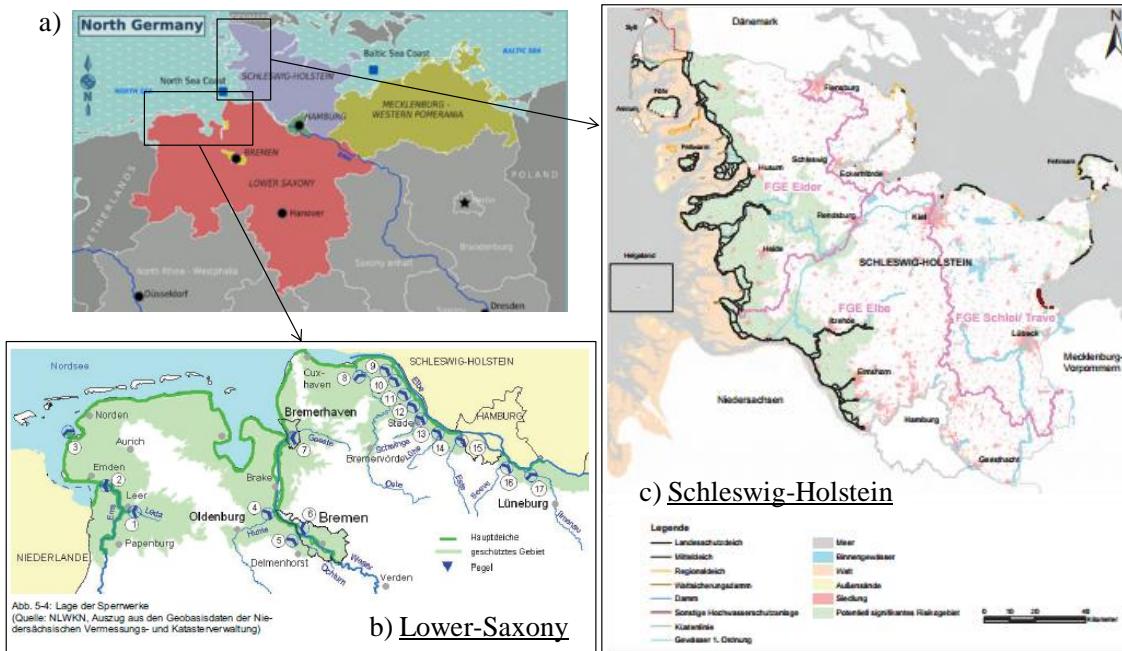
123 The German North Sea coast includes the coastline of the Federal states of Schleswig-Holstein,
124 Hamburg and Lower-Saxony (Fig. 1). Traditionally, the German as well as the whole trilateral
125 Wadden Sea Region has been an important agricultural area having been developed over
126 centuries (Kabat et al., 2012). Additional current economies are tourism, the energy sector (on-
127 shore, off-shore wind and solar energy) and fishery, as well as port industry and trading in
128 specific places. Important ports, namely the ports of Hamburg, Bremerhaven/Bremen,
129 Wilhelmshaven, have influenced the economic and social development (Kabat et al., 2012).
130 Tourism has developed into the most important economic sector, on the mainland and especially
131 on the islands, with an important share of the regional employment level. In addition to tourism,
132 the service sector is heterogeneous and represents different economic sub-sectors such as sale
133 and retail trade, business services, education, health services and social care, and public
134 administration (Wadden Sea Forum, 2004; van Dijk et al., 2016).

135 Within the German North Sea coast, approximately 2 million inhabitants² live and work in low-
136 lying areas. The height of marshland in Lower Saxony lies approximately between +1.4 m
137 above mean sea level (MSL) up to 0.5 m below MSL. Older parts of the marshes sometimes lie
138 even up to 2 m below MSL (NLWKN, 2007). In these low-lying areas social development, in
139 addition to economic activities, is only possible thanks to a long-lasting and constantly
140 improved coastal protection system. Approximately 9,000 km² are covered by strategic storm
141 surge management plans³ (areas up to a height of +5 m above sea level). In order to protect

² With regards to the year 2011 (Source: WSF, based on Regionaldatenbank Germany).

³ 6,600 km² in Lower Saxony (Generalplan Küstenschutz Lower Saxony, 2007); 2,400 km² in Schleswig-Holstein (Generalplan Küstenschutz Schleswig-Holstein, 2012), area of the Tideelbe is not included.

142 settlements and agricultural land against flooding and damage due to storm surge events, as well
 143 as the effect of rising sea levels, protective structures (dwelling mounds, ring dykes, closed dyke
 144 lines) have been installed along the coast since the beginning of the 10th century (Oost et al.,
 145 2012; Wadden Academy, 2013).



146

147 **Fig. 1.** Study area: the German North Sea coast (a), including the states of Lower-Saxony (b) and Schleswig-Holstein
 148 (c). Historical flooded areas are highlighted in green colour. Current coastal protection dykes are shown with green
 149 and black lines in b) and c) respectively. Source: Generalplan Küstenschutz des Landes Schleswig-Holstein
 150 (MELUR, 2013) and Generalplan Küstenschutz Niedersachsen/ Bremen -Festland- (NLWKN, 2012).

151 Numerous disastrous storm surge events hitting the German North coast including loss of lives
 152 and goods (see Table 2) give reason to continuous improvement of coastal protection facilities
 153 still being carried out today. In recent years, the last storm surge events which caused huge
 154 losses along the Wadden Sea coast were the Holland flood in 1953 and the flood of February
 155 1962. Both events involved significant transformations in storm surge management in Germany
 156 including a strengthening of administrative structures (von Storch et al., 2008; Gerritsen, 2005;
 157 FAK, 2009). A new dyke maintenance program was adopted in the federal states of Lower
 158 Saxony, Schleswig-Holstein, Bremen and Hamburg. It included modifications of the dyke line
 159 (reducing and straightening the dyke line, enlarging the bottom of the dykes etc.) and changed
 160 legal regulations. The latter allowed governmental institutions to take the lead in coastal
 161 protection issues. Following the Basic Constitutional Law (*Grundgesetz*) that identifies coastal
 162 protection as an issue of concurrent legislation⁴ of the Federal Republic of Germany, the federal
 163 states are responsible for coastal protection. This federal state responsibility is exercised by the
 164 Ministry of Environment, Energy and Climate Protection in Lower-Saxony, and by the Ministry
 165 for Agriculture, Environment and Rural Areas in Schleswig-Holstein. In general, decision-
 166 making processes in current German storm surge management are organized in a hierachic top-
 167 down order, including governmental actors such as ministries, state agencies, counties,
 168 provinces and municipalities as well as local dyke associations⁵ and water boards. Following the

⁴ Concurrent legislation in coastal protection means that the Federal States have the power of legislation processes in coastal protection issues as long as the state does not make use of its (superordinate) right of legislation on this issue.

⁵ Dyke associations are the German version of water boards with a comparable organization structure and responsibility in all three Wadden Sea states along the North Sea coast (NLWKN 2008). The current state of the

169 accretive institutionalization in coastal protection especially after World War II, responsibilities
170 have shifted from the local to the state level, and there are no longer tasks related to the
171 inhabitants and non-governmental actors in flood-prone areas.

172 Following the improved state led programs, enormous technical efforts and huge financial
173 inputs were carried out over the years to improve coastal protection facilities up to their current
174 state. Presently, the technical superiority of engineering-based coastal protection measures
175 versus soft-measures has had an important influence on storm surge risk management in
176 Germany. Existing highly developed coastal protection measures along the German North Sea
177 coast have been built to provide high protection levels for current climate conditions and most
178 likely the next decades (MLR, 2001; MELUR, 2013; NLWKN, 2007; Sterr, 2008).

179 **Table 2.** Summary of important historic storm surge events at the German North Sea Coast (NLWKN 2007;
180 Jensen and Müller-Navarra, 2008; MunichRE⁶). The historical flooded area is shown in Figure 2. UK: United
181 Kingdom, FR: France, BE: Belgium, NL: Netherlands, GE: Germany (*SH: Schleswig-Holstein, LS: Lower-Saxony*),
182 PO: Poland, DK: Denmark, NW: Norway, SW: Sweden, N/A: information not available.

| Date | Name and description of main impacts in Germany | Countries affected | Number of casualties |
|---------------|---|------------------------|----------------------|
| 17.02.1164 | St. Julian flood | NL, GE | 20,000 |
| 16.01.1219 | <i>1st Marcellus flood.</i> Huge flooding in the River Elbe area; first historically transmitted eyewitness account. | NL, GE | 36,000 |
| 14.12.1287 | <i>St. Lucia's Flood.</i> Beginning of formation of Dollart Bay | UK, NL, GE | 50,000 - 80,000 |
| 16.01.1362 | <i>2nd Marcellus flood/ "Grote Mandrenke".</i> First embayment of the Dollart bay between NL and GE; destruction of a huge part of North Frisia. | BE, NL, GE, DK | 100,000 |
| 27.9.1477 | <i>1st Cosmas and Damian flood.</i> | NL, GE | several thousands |
| 01.11.1436 | <i>All Saints' Flood.</i> Impacts on Sylt island, human migration. | GE | >180 |
| 06.01.1470 | <i>Three Kings' Flood.</i> | GE | N/A |
| 26-27.9.1509 | <i>2nd Cosmas and Damian flood</i> | NL, GE | N/A |
| 11.10.1634 | <i>Burchardi Flood/2nd "Mandraenke".</i> Island of "Strand" destroyed; remnants of Strand are Nordstrand and Pellworm islands. | GE | 8,000-15,000 |
| 22.02.1651 | <i>St. Peter's Flood.</i> East Frisian island of Juist (LS) split in two. | GE | 15,000 |
| 07.12.1703 | <i>Great Storm of 1703.</i> | UK, BE, NL, GE | 8,000-15,000 |
| 24/25.12.1717 | <i>Christmas flood.</i> Highest and most disastrous storm surge event of its time. | NL, GE, DK | 14,000 |
| 03/04.02.1825 | <i>February Flood 1825.</i> Many dyke breaches and heavy losses of dunes on islands; highest flood level until 1962. | NL, GE | 800 |
| 31.01.1953 | <i>1953 North Sea flood.</i> Historically important flood mostly affecting NL with water level above 5.6 m that overwhelmed sea defences. | NL, BE, UK | 2,551 (NL 72%) |
| 16-17.02.1962 | <i>February Flood 1962/ Hamburg flood.</i> Heavy storms flood in the North Sea coast, mainly Hamburg. Highest flood level. | NL, GE | 340 (GE 90%) |
| 03.01.1976 | <i>Gale of January 1976.</i> Highest level at many tidal gauges, dyke breaches along the coast of SH and the Elbe river. | GE | 0 |
| 24.11.1981 | <i>North Frisian Flood.</i> Highest water levels in North Friesland | DK, GE | 0 |
| 21/22.01.1993 | Several storm surges, sand depletion on Sylt island. | GE | 0 |
| 28.01.1994 | Hamburg, Schleswig-Holstein | GE | 0 |
| 03.12.1999 | <i>Cyclone Anatol.</i> Floods along the entire North Sea coastline. | GE, DK, SW, NL, DK | 20 (DK) |
| 30.01.2000 | Floods in SH, water level above 5.16m in Hamburg, sand depletion on Sylt island. | GE, DK | 0 |
| 09.11.2007 | <i>North Sea flood of 2007/Cyclone Tilo.</i> Huge destruction of dunes on the island of Helgoland. | BE, NL, UK, GE, DK, NW | 0 |

German dyke associations is related to a long historic development; its original structures predominantly results from loose forms of loose interest groups and village communities.

⁶ MunichRE. Historical storm surge events in the North Sea. Available at:

https://www.munichre.com/site/corporate/get/documents_E1318646163/mr/assetpool.shared/Documents/0_Corporate%20Website/6_Media%20Relations/Press%20Dossiers/50th%20anniversary%20storm%20surge%20hamburg/historical-storm-surge-events-en.pdf (last accessed 21/01/2017)

| | | | |
|---------------|---|--|---|
| 04-06.12.2013 | <i>North Sea flood of 2013/Cyclone Xaver.</i> Waves up to 6m high, second highest record since 1825. Loss of land and dunes on the island of Sylt and the east Frisian islands. | UK, FR, BE, NL, GE, PO, DK, NW, SW | 0 |
|---------------|---|--|---|

183

184 3.2. Stakeholder sample

185 According to the EC guidelines (2002), the main governmental and non-governmental actors in
 186 the study area have been identified and consulted, covering all relevant socioeconomic sectors
 187 and administrative levels. In total, 288 stakeholders were identified in the study area including
 188 those involved in management processes and those whose activities could be potentially
 189 affected by storm surge impacts. The comparison of the perceptions associated with these *two*
 190 *sides of the same coin* provides an in-depth look at existing incoherencies that could bring about
 191 failures in risk and emergency management.

192 The stakeholders were initially contacted by phone and/or email in order to establish a personal
 193 contact and ensure that the objective and method of the study were understood. Only afterwards,
 194 was access to the online survey provided. The questionnaire, in German language and available
 195 online for 3 months (for Schleswig-Holstein: Sep.-Nov. 2014; for Lower-Saxony: Jun.-Aug.
 196 2015), was answered by 174 stakeholders (60%). After validating this preliminary database, the
 197 final stakeholder sample includes 116 stakeholders. Out of these, 58 stakeholders were from
 198 Lower-Saxony, 57 from Schleswig-Holstein and 1 described him/herself as from the Wadden
 199 Sea Region. The respondents were classified by type of organization, geographical scope⁷ and
 200 sector (Table 3), and their answers analysed accordingly. The institutional authorities are those
 201 stakeholders who are responsibility for dealing with the management of a specific topic, with a
 202 strategic planning/legislative function. The public agencies are responsible for implementing the
 203 strategies, having therefore an executive function. This group includes agency departments
 204 working voluntarily especially at the local level, such as fire brigades and the Federal Agency
 205 for Technical Relief (THW), among others. The private sector and sectoral associations are
 206 those whose main activities are related to the economic sectors either as for profit businesses or
 207 as groups/associations that lobby for their common economic interests, neither of which are
 208 controlled by the government. The NGOs (non-governmental organization) are those not-for-
 209 profit organizations that are independent from the government and are oriented to specific
 210 sectors or affairs, such as social, environmental, emergency, etc.

211 **Table 3.** Stakeholders sample (N) by type of organization (A), geographical scope (B) and sector (C). Total sample:
 212 N=116

| A. Type of organization | N _A (%) | B. Geographical scope | N _B (%) |
|-------------------------------------|--------------------|-----------------------|--------------------|
| Institutional authority | 37 (32%) | National | 9 (8%) |
| Public agency | 36 (31%) | State | 27 (23%) |
| Private sector/sectoral association | 29 (25%) | District | 31 (27%) |
| NGO | 14 (12%) | County | 7 (6%) |
| | | Community | 25 (22%) |
| | | Other (multi-scope) | 17 (15%) |
| C. Sector | N _C (%) | C. Sector | N _C (%) |
| Agriculture and farming | 9 (8%) | Education | 1 (1%) |
| Tourism | 7 (6%) | Social | 3 (3%) |
| Industry | 2 (2%) | Ports and navigation | 3 (3%) |
| Environment | 9 (8%) | Water | 4 (3%) |
| Coastal protection | 14 (12%) | Fisheries | 3 (3%) |
| Emergency | 37 (32%) | Security and defence | 2 (2%) |
| Administration | 19 (16%) | Other | 3 (3%) |

213

⁷ Federal States (*Länder*) in Germany are divided into districts (*Kreise*) and communities (*Gemeinden*), districts being grouped in counties (*Ämter*).

214 *3.3. Results on storm surge risk perception and resilience*

215 The data collected through the survey has been analysed following three approaches: in general,
216 considering all the answers regardless of the characteristics of the respondents, by location, and
217 by type of stakeholder. The analysis of answers by location shows very similar outcomes
218 between the Lower-Saxony and Schleswig-Holstein databases (positive covariance), as well as a
219 strong linear association between the answers (Pearson correlation coefficient: $r>0.9$ for 62% of
220 the questions, $r>0.8$ for 90% of the questions). This allows generating results and conclusions
221 by type of stakeholder that can be extrapolated to both locations.

222 To facilitate the presentation of the results this chapter is structured as follows: (1) individual
223 preparedness and the intention to prepare, (2) community preparedness and the intention to
224 collaborate, and (3) enhanced coordination and collaboration schemes. Therefore, in some cases
225 the results will not strictly follow the order of the questionnaire.

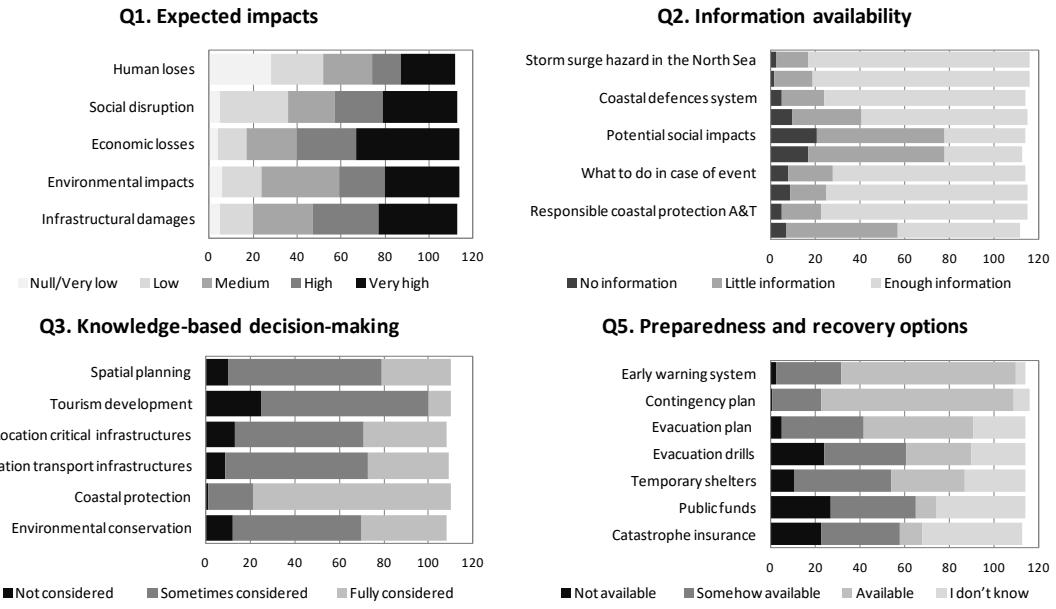
226 *3.3.1. Individual preparedness: the intention to prepare*

227 The factors conditioning the intention to prepare depend, on the one hand, on the institutional
228 preparedness and the perception of society, the quality and availability of risk information, and
229 its use in sectoral planning as an insight of risk governance. On the other hand, they depend on
230 the perceived risk and the adoption of protective behaviours, with factors such as critical
231 awareness, trust, experience and behavioural patterns. This section is structured accordingly.

232 *Risk information and stakeholders' perception*

233 Understanding the risk and making risk information available for both public and sectoral
234 decision-makers is crucial. Risk communication efforts succeed when they boost the
235 involvement of people in the debate, create a better understanding of the situation and
236 subsequently translate into more protective behaviours (Paton and Johnston, 2006). This highly
237 depends on the design of tailored and comprehensive communication strategies in contrast to
238 those based only on information provision. The results presented in this section help understand
239 the perception of the stakeholders on the quality, availability and use of risk-information, as
240 well as the knowledge and opinion they have regarding institutional preparedness on flood
241 protection, warning, evacuation, and recovery measures.

242 The main storm surge impacts expected on the German North Sea coast (Q1, Fig. 2) relate to the
243 economic, infrastructural and social dimensions, with 64%, 57% and 48% of the respondents,
244 respectively, assigning high and very high impacts. When comparing the answers by type of
245 stakeholder, it can be seen that the authorities and public agencies expect higher impacts than
246 the private sector stakeholders. This can be a signal of a lower awareness in this last group due
247 to a probable lower access to information. When asked about the amount and quality of the
248 information provided by the responsible authorities on several storm surge issues (Q2, Fig. 2),
249 the perceived lack of information precisely on these impacts and on how to deal with them
250 stands out compared to other issues. 68% and 69% of respondents highlighted that there is
251 no/little information for social and economic impacts, respectively, followed by 51% for risk
252 reduction measures and 36% for the potentially flooded areas. By type of stakeholder, the
253 perceived lack of information is represented by 34% of the answers from institutional
254 authorities, 30% of those from public agencies, 42% of those from private sector and sectoral
255 associations, and 31% from NGOs' answers. These results highlight the need to improve the
256 risk communication strategy to reach every type of stakeholder, paying special attention to
257 specific topics and sectors, in order to increase risk awareness and meet society's expectations.



258

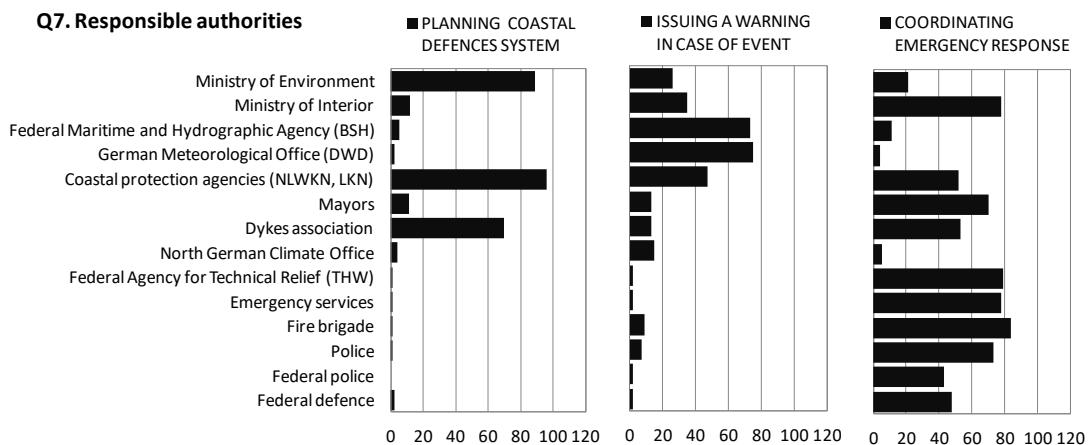
259 **Fig. 2.** Results about risk information and stakeholders' perception (x-axis: number of answers). Q1: expected
260 impacts, Q2: information availability (A&T: authorities and teams), Q3: knowledge-based sectoral decision-making,
261 Q5: preparedness and recovery options.

262 Disaster risk governance, i.e. mainstreaming and integration of DRR within and across sectors
263 at all administrative levels, is crucial for an effective and efficient DRM (UN/ISDR, 2015). The
264 extent to which the storm surge information is considered in the different sectoral planning
265 processes of the study area (Q3, Fig. 2) is perceived as quite low for most of the sectors except,
266 logically, that of coastal protection. Only 9% of the respondents think storm surge risk is fully
267 taken unto consideration in tourism development, 28% think it is considered for the spatial
268 planning and 33-35% for the location of critical and transport infrastructures as well as the
269 environmental protection. Furthermore, a lack of sectoral interlinkages and information sharing
270 can be observed. Integrating risk knowledge within sectoral decision-making and sectoral
271 interests within risk management provides an opportunity to better protect society, livelihoods,
272 the environment and assets.

273 The question regarding the availability of preparedness/recovery options and the knowledge of
274 the stakeholders about them (Q5, Fig. 2) shows a general lack of information. This statement is
275 based on the small percentage of positive answers (37%), i.e. "information available", the
276 number of contradictory answers in most of the items, i.e. "available" vs. "not available", and
277 the percentage of "I don't know" answers (21%). The "I don't know" option represented 27%,
278 25%, 20% and 17% of the answers from NGOs, sectors, public agencies and authorities,
279 respectively. The early warning system and contingency plans are better known to the
280 stakeholders than evacuation plans, drills and temporary shelters, for which the stakeholders'
281 certainty decreases resulting in contradictory responses that should be taken into consideration
282 for better information strategies. Most of the respondents do not know if economic instruments
283 are available to deal with the risk. These results show a clear information gap and a demand for
284 better communication strategies regarding preparedness/recovery options, especially those
285 oriented to sectors and NGOs. These strategies will foster community preparedness options and
286 proactive behaviours.

287 The respondents satisfactorily identified the available official warning mechanisms (Q6), with
288 radio, TV and internet being the most known ones, followed by sirens, SMS and loudspeakers.
289 Some stakeholders mentioned additional warning systems such as fire brigade alerts, social

290 media and journals in Schleswig-Holstein, and smartphone-Apps (specifically KatWARN) and
 291 the notification system from the Federal Maritime and Hydrographic Agency (BSH) in Lower-
 292 Saxony.



293

294 **Fig. 3.** Results on risk information and stakeholders' perception (x-axis: number of answers). Q7: responsible
 295 authorities.

296 When asked about the authorities responsible for the different processes within storm surge risk
 297 management (Q7, Fig. 3), the main authorities are correctly identified; however, the results also
 298 show also some confusion regarding responsibilities and roles. As far as the *planning of the*
 299 *coastal defence system is concerned*, the Ministry of Environment⁸ is in charge of the strategic
 300 planning of coastal protection issues, in collaboration with the Coastal Protection agencies⁹,
 301 which are also responsible for the guidance and supervision of construction and maintenance.
 302 63% of the answers correctly identified these two bodies, 24% having selected the Dykes
 303 Associations¹⁰, which are in charge of dyke maintenance but not the planning. *Issuing and*
 304 *publishing the flood warnings* in case of a storm surge event is carried out by the BSH in
 305 connection with the German Meteorological Office (DWD). These two bodies were selected by
 306 46% of the respondents. The *emergency operations* are coordinated by the Federal Agency for
 307 Technical Relief (THW) from the Ministry of Interior, supported by partners such as the fire
 308 departments, the Red Cross, the Federal Police and the Army. Only 11% of the respondents
 309 identified this agency as responsible; however, 47% selected the supporting partners as
 310 responsible. The institutions involved in the different tasks within storm surge risk management
 311 are in general well known, especially those related to coastal protection; however, the
 312 responsible authorities are not precisely identified by the respondents and in all likelihood
 313 would not be identified by the society in general either. Improving the communication strategy
 314 on responsibilities, roles, procedure and tasks within risk management would facilitate the
 315 implementation of the various current initiatives, as well as the identification of potential roles
 316 and tasks in which community representatives could get involved, as suggested by UN/ISDR
 317 (2015).

⁸ Ministry for Agriculture, Environment and Rural Areas –MELUR– (Schleswig-Holstein); Ministry for Environment, Energy and Coastal Protection (Lower-Saxony).

⁹ Agency for Coastal Protection, National Parks and Ocean Protection –LKN– (Schleswig-Holstein); Agency for Water Management, Coastal Defense and Natural Conservation –NLWKN– (Lower-Saxony).

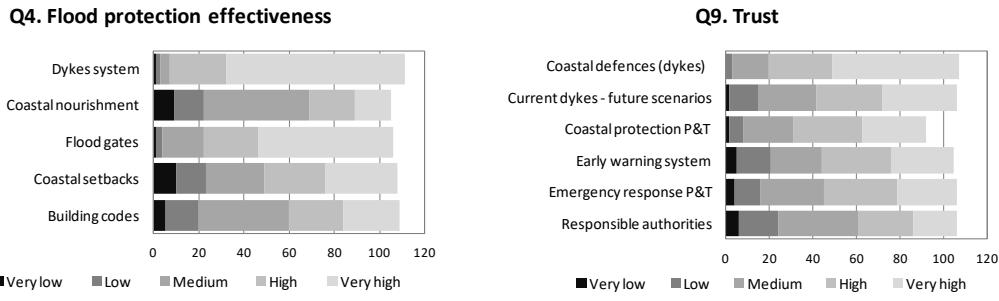
¹⁰ Water Boards and Land Associations –LVB– (Schleswig-Holstein); Dykes associations (Lower-Saxony).

318 *Perceived risk and adoption of protective behaviour*

319 Risk perception, as a societal protective behaviour predictor (Douglas and Wildawsky, 1982;
320 Lindell and Perry, 2000; Sjöberg et al., 2004; Renn, 2008; Birkmann et al., 2012), is
321 conditioned by the coverage and quality of information provided by the authorities, the trust in
322 the source providing the information (Paton 2003, 2010; Basolo et al., 2009; Becker et al.,
323 2011), the societal critical awareness (Dalton et al., 2001; Paton, 2003, 2005, 2010; Becker et
324 al., 2011, 2013), and by previous flooding experiences (Birkmann et al., 2012; Becker et al.,
325 2013).

326 Storm surge critical awareness (Q8), understood as the degree to which the hazard is a
327 prominent topic within society's conversations and concerns, is very low since storm surge is
328 among the three problems the respondents less worry about from a list of 13. This reflected low
329 relevance and less urgency against other problems regarding intention to prepare. Economy,
330 family, politics, society and environment go first: unemployment (24%), private problems
331 (19%), general political problems (13%), demographic change (9%), followed by environment
332 (7%), energy (7%) and climate change (7%) are the issues that mainly concern the society and
333 on which people focus their daily efforts in the study area. Storm surge is neither perceived as
334 an urgent problem to deal with, nor is prompt action perceived as necessary. Therefore, it is
335 supposable that only basic protective measures take place on the personal/individual level.

336 The lower urgency of storm surge risks stems partly from a strong trust in currently applied
337 management systems. Comparing the trust of the respondents on several aspects related to storm
338 surge management (Q9, Fig. 4), the current coastal defences today and for future climate
339 scenarios receive much higher trust levels than emergency procedures, teams and authorities.
340 This lower trust in authorities and methods could lead to a reduced support from society (Paton
341 2003, 2010; Basolo et al., 2009; Becker et al., 2011). The analysis by type of stakeholder shows,
342 however, that sectoral stakeholders have higher trust in most of the issues, including the dykes,
343 than the authorities and public agencies responsible for them. This higher trust could be related
344 to a lower awareness, a lower access to pertinent information, or simply to the reliability of the
345 existing coastal protection system and its success over the last 50 odd years. This conclusion is
346 very well complemented by the results of the question regarding the effectiveness of the various
347 flood protection measures (Q4, Fig. 4), which shows much higher credibility from the
348 respondents on hard engineering measures, such as dykes and flood gates, with 94% and 79% of
349 respondents, respectively, assigning them a high-very high effectiveness, than on soft measures
350 like coastal nourishment, setbacks and building codes, for which the percentages decrease to 34-
351 55%. In conclusion, the survey shows that there is high trust in coastal protection measures
352 since their reliability has been proven several times in the past. However, the safety feeling
353 behind the dykes or excessive unproven trust values could hinder the adoption of additional
354 protective behaviours by society. Exploring options for an active individual involvement and
355 sharing responsibility might (re)create ownership, which is just as important as trust, and
356 credibility in authorities and teams. Exploring options for soft measures and starting a
357 transparent discussion about alternative choices might broaden the range of protection schemes.
358 Increased societal knowledge, awareness and acceptance are important, but receptiveness for
359 appropriate and relevant information is a precondition. This should be considered in a suitable
360 communication strategy.



361

362 **Fig. 4.** Results on intention to prepare related to safety feelings and trust (x-axis: number of answers). Q4: flood
363 protection measures, Q9: trust.

364 Regarding experience with storm surge events (Q10), 86% of the stakeholders interviewed have
365 experienced in their life at least one major storm surge flooding, of which only 6% have
366 experienced important impacts, with their livelihoods and/or properties being highly affected.
367 14% have never experienced such an event. Life experiences may influence one's risk
368 perception and enhance the intention to prepare. When asked if they feel at risk (Q11), 57% of
369 the respondents think their main living activities are located in a potentially flooded area, this
370 percentage rising to 64% for their main working activities, 55% think their public/private sector
371 is threatened by storm surge flooding, and 56% think that it could be potentially disrupted by a
372 major event. However, only 13% of the respondents are looking for information to understand
373 the hazard and better cope with it. Even though risk is perceived, the success of the coastal
374 protection system and the low frequency of events may affect the readiness and intention to
375 prepare. There is room for challenging thinking to increase awareness and intention rather than
376 wait for the next event.

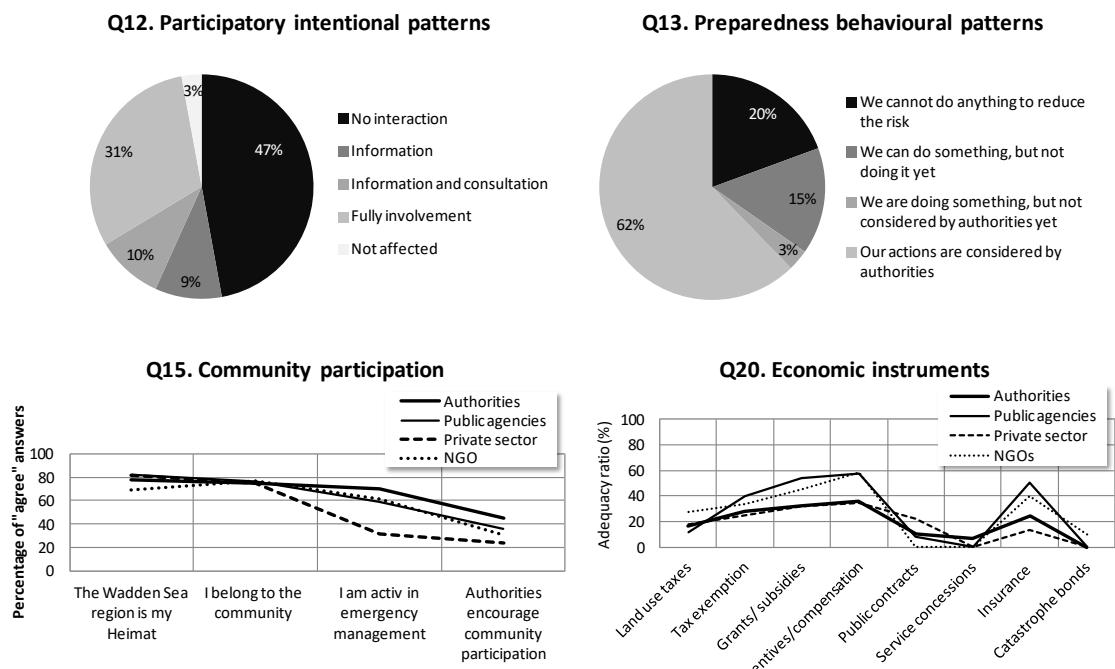
377 3.3.2. Community preparedness: the intention to collaborate

378 DRR requires responsibility sharing among stakeholders, an all-of-society engagement and
379 partnership, and the empowerment of local authorities and local communities (UN/ISDR, 2015).
380 Ensuring the integration of local community action increases the effectiveness of DRM
381 interventions, since these are then not imposed on the community, but rather accomplished by
382 those concerned (De Guzman, 2003). The institutions shall provide the enabling environment
383 for community-based adaptation planning and implementation (Cutter et al., 2012), in order to move
384 from a basic participatory approach based solely on information provision, towards a fully
385 collaborative approach. The success of collaborative approaches strongly depends on inclusive,
386 accessible and non-discriminatory participation strategies (UN/ISDR, 2015), as well as on
387 organizational structures and systems that facilitate and ensure coordination of stakeholders'
388 actions and contributions (De Guzman, 2003).

389 To understand the current intentions to both prepare and collaborate we need to analyse two
390 community patterns: participatory intentional patterns and preparedness behavioural patterns.
391 The participatory intentional patterns (Q12, Fig. 5) refer to the level of involvement
392 stakeholders think their sector should have within risk management. 50% of respondents prefer
393 a participatory risk management, although with different involvement levels: 9% want to be
394 informed by the authorities before taking decisions, 10% to be informed and consulted, while
395 31% suggest more participative and integrated approaches in storm surge risk management, as
396 they believe they can actively contribute with their knowledge and actions. These answers made
397 clear that there is some willingness and attitude towards participative management approaches.
398 However, 47% trust and accept the authorities' decisions, expecting no interaction. This group

399 is represented by 58%, 42%, 46% and 33% of the answers from authorities, public agencies,
400 sectoral stakeholders and NGOs, respectively.

401 The question on preparedness behavioural patterns (Q13, Fig. 5) assesses the society's current
402 preparedness behaviour and its acceptance and internalization by the authorities. Accordingly, it
403 includes on the one hand, the perceptions of whether personal actions will effectively mitigate
404 or reduce a problem (outcome expectancy), the beliefs regarding personal capacity to act
405 effectively (self-efficacy), and the predisposition to choose action directed at changing a
406 situation (action coping), as per Paton (2003, 2005, 2010) and Becker et al. (2011, 2013). On
407 the other hand, it assesses whether the authorities are considering the actions taken by the
408 stakeholders to reduce the risk. 20% of the respondents think that only risk authorities and
409 infrastructures can reduce the potential impacts on their sector, with the percentage rising up to
410 25% when analysing only the sectoral stakeholders. This reflects a clear transfer of
411 responsibility for safety towards the authorities and a high trust in structural mitigation, as
412 shown in Q4 and Q9, which can lead to reduced protective behaviours, as stated by Ballantyne
413 et al. (2000). However, 80% of the respondents show a pro-active behaviour at different levels:
414 15% think their sector can do something to reduce the risk but is not yet working on it, and 65%
415 believe it is already doing something. From this last group, 95% think that their interests and
416 actions are already included in the risk management planning developed by the authorities. This
417 fact reflects a high level of support and empowerment towards the authorities.



418
419 **Fig. 5.** Results on intention to collaborate. Q12: participatory intentional patterns, Q13: preparedness behavioural
420 patterns, Q15: community participation, Q20: adequacy of economic instruments.

421 The question regarding currently applied preparation measures (Q14) shows that 25% of the
422 respondents undertake temporary protection measures, 24% permanent measures, 13%
423 evacuation measures (only respondents from Schleswig-Holstein), and 10% is covered by
424 insurance. The other 28% undertake no measures at all although many of them state that they
425 are not located in an exposed area. When asked about the main constraints they face to take on
426 these measures, besides general time/cost constraints, respondents perceive a lack of support on
427 behalf of the authorities to carry out permanent measures. In Schleswig-Holstein the lack of

428 support on the part of insurance companies is also relevant, which in contrast is not the case in
429 Lower-Saxony. The results show a general demand for institutional and insurance support to
430 enhance and facilitate the adoption of site-specific and plausible measures.

431 To explore in depth the perception regarding economic instruments to be promoted by
432 authorities and/or insurance in the region to adapt to the storm surge risk (Q20, Fig. 5), the
433 respondents were asked about the extent to which they agree with the application of land use
434 taxes/dykes taxes¹¹, tax exemption¹², grants/subsidies¹³, incentives/compensation¹⁴, public
435 contracts¹⁵, service concessions¹⁶, insurance¹⁷, and catastrophe bonds¹⁸. None of the measures
436 receive significant acceptance, especially the catastrophe bonds, service concessions, land use
437 taxes and public contracts, with 91%, 77%, 74% and 55% of respondents, respectively, rating
438 them as inadequate/very inadequate. Incentives/compensation and grant/subsidies are the most
439 accepted measures with 45% and 40% of respondents, respectively, rating them as
440 adequate/very adequate. Focusing on this type of answers, the “adequacy ratio” by type of
441 stakeholder illustrates more critical opinions towards the authorities and private sector. Potential
442 economic instruments and adaptation options should consider the current disagreement with
443 most of the presented options, in order to design tailored and site-specific measures.

444 The question on community participation (Q15, Fig. 5) looks into the attachment of the
445 respondents to the study area (using the German concept of *Heimat*; Ratter and Gee, 2012) and
446 to the local community, their involvement in emergency management activities, and the support
447 thereof by the authorities. Analysing the “agree” and “strongly agree” answers by type of
448 stakeholder, around 80% for all types feel that the Wadden Sea Region and, specifically, the
449 place where they live is their Heimat, and they feel that they belong to the community and work
450 with others to solve common problems. Out of all respondents, around 60-70% are somehow
451 active in emergency management at the local level, except the private sector with only 32% of
452 respondents being active. The percentages of respondents that think the authorities encourage
453 the community to have an active role in emergency management are much lower: 45%, 35%,
454 24% and 31% for the authorities, public agencies, private sector and NGOs, respectively. The
455 results show that the bases for engaging the community are set, however the private sector and
456 sectoral associations don't feel the full involvement of the authorities. Institutional support in
457 community participation could be improved to enhance the intentions and expectations of
458 society to collaborate.

459 Participants were asked about active stakeholders in storm surge management in the study area
460 that could help encouraging a participative approach in the preparedness of the community
461 (Q16). The answers on this open question reflect in most cases the responsible authorities
462 identified in Q7, and they include some additional stakeholders such as port authorities,
463 authorities at different levels (counties, districts), farmers, and the national park administration.

¹¹ Flood prone land owners finance coastal protection.

¹² Tax exemption for private investment in permanent flood protection.

¹³ Grants/subsidies as financial support for private investment in permanent flood protection.

¹⁴ Incentives/compensation for giving up land.

¹⁵ Public contracts to perform a particular task that benefit the community funded by government funds.

¹⁶ Service concessions to have the exclusive right to operate, maintain and carry out the investment in a public utility for a given number of years, this including the right to charge the final users of the product.

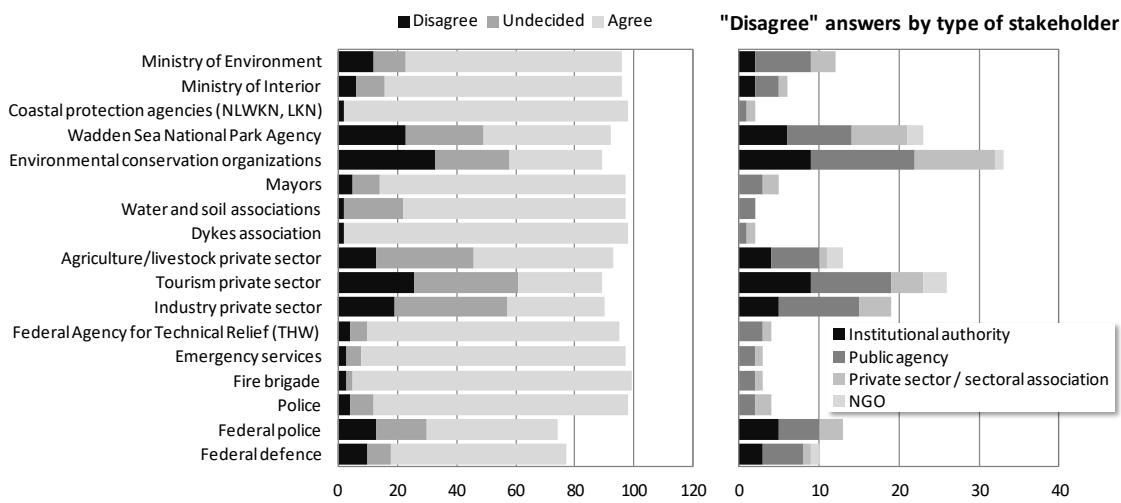
¹⁷ Insurance financing losses caused by storm surge events.

¹⁸ Disaster risks are securitized in the financial markets, the investor receiving a return if a catastrophe does not occur during the contract, but sacrificing interest or part of the principal if the event does occur.

464 3.3.3. Enhanced coordination and collaboration schemes

465 According to the Sendai Framework, coordination mechanisms within and across sectors and
 466 with relevant stakeholders at all levels are crucial for enhanced DRR. A full engagement of all
 467 State institutions and a clear articulation of responsibilities among public and private
 468 stakeholders will ensure shared outreach, partnership, complementarity in roles, liability and
 469 follow-up. While the role of national and federal State Governments remains essential, it is
 470 necessary to empower local authorities and communities to reduce disaster risk through
 471 resources, incentives and decision-making responsibilities (UN/ISDR, 2015).

Q17. Partnerships structure



472

473 **Fig. 6.** Results on enhanced coordination and collaboration schemes (x-axis: number of answers). Q17: DRM
 474 partnership structure.

475 In this context, the stakeholders were asked about the structure of a potential partnership to deal
 476 with risk management (Q17, Fig. 6). Responsibility-sharing between public and private sectors
 477 and civil society organizations through partnerships is a current paradigm to improve DRM
 478 through enhanced understanding and support (UN/ISDR, 2014). The answers show large
 479 consensus on the involvement of those stakeholders related to the coastal protection
 480 (LKN/NLWKN, Dyke associations) and the emergency (THW, Red Cross, DLRG, German
 481 Maritime Search and Rescue Service, fire brigades, etc.). However, the involvement of sectoral
 482 stakeholders (agriculture/livestock, tourism and industry private sectors) and environmental
 483 stakeholders (Wadden Sea National Park and environmental conservation organizations) have
 484 the highest number of disagreements. The involvement of authorities (ministries, mayors) is
 485 also subject to some disagreement. On this point, stakeholders are clearly divided over their
 486 significance. Disagreement shown in Q17 contrasts with the answers given in Q16 (see
 487 penultimate paragraph) where precisely these stakeholders were mentioned by several
 488 respondents as active stakeholders in storm surge management that could help encourage a more
 489 participative approach. Additionally, analysing the Q17 answers by type of stakeholder, the
 490 public agencies show lower interest in interdisciplinary participatory approaches with a
 491 disagreement ratio of 18% in their answers, affecting to a greater or lesser extent all the
 492 proposed potential candidates. The disagreement ratio for authorities, private sector and NGOs
 493 is 9%, 11% and 5%, respectively. The exclusion of the sectoral stakeholders is coherent with the
 494 results obtained in Q15, in which sectors showed a lower participation related to a low
 495 institutional support. To follow the UN/ISDR guidelines (2015) regarding DRR partnerships to

496 be fostered in the region, previous awareness campaigns regarding the relevance of this
497 integrated approach should be promoted.

498 When asked about their willingness to participate in such a partnership (Q19), 84% of the
499 respondents stated that they personally (42%) or their organization (42%) would consider the
500 initiative to be useful and would participate, while 14 % stated that their organization would
501 consider it useful but that they see at present no need for direct participation, and 2% sees no
502 personal/professional benefit in it. In general, a willingness to participate and collaborate can be
503 observed. The ratio of those who are somewhat reluctant to participate is 14%, 17%, 19% and
504 13% for authorities, public agencies, sectoral stakeholders and NGOs, respectively. The sectors
505 have the highest percentages, which is consistent with the results of Q15 and Q17 just
506 presented.

507 The three main expected benefits from a potential partnership (Q18) are the increased
508 collaboration between stakeholders (20%), the possibility to develop long-term strategies (18%)
509 and the consideration of the interests of all parties (13%), followed by the increased discussion
510 (11%) and the gain of knowledge about DRM (11%). The main expected difficulties to be faced
511 have to do with the effective implementation of the decisions potentially taken (25%), the
512 proper collaboration between stakeholders (21%) and to people's time (16%), followed by the
513 long-term implementation (15%). The identified and ranked challenges provide essential
514 information to design and manage the partnership in such way that these problems are
515 minimized. It is worth noting that some of the issues appear both as benefits and difficulties, i.e.
516 collaboration and long-term effective implementation. This means that these issues may
517 currently not be satisfied in other similar initiatives and should be the key objectives in the
518 future, in order to foster their success in the long-term and fulfil society's expectations.

519 3.3.4. Summary and discussion of major findings

520 The major findings of the study represent a diagnosis on the perception of society, the intention
521 to prepare and collaborate, and the opinions regarding enhanced collaboration schemes. Such a
522 diagnosis is the starting point to meet the guidelines and priorities proposed in the Sendai
523 Framework for DRR (UN/ISDR, 2015), and helps to identify both strengths to maintain and
524 weaknesses to target and minimise when designing further DRM initiatives. To better
525 understand the scenario regarding the Sendai Framework, Table 4 analyses the results against
526 the Sendai priorities.

527 **Table 4.** Relation between the resilience results and the UN/ISDR Sendai Framework Priorities (P: Sendai
528 Priorities, Q: Resilience questions)

| Sendai Priorities | Scenario results (% of respondents) |
|--|---|
| <i>P1. Policies and practices for DRM should be based on an understanding of disaster risk in all its dimensions. Strengthening public education and awareness is crucial.</i> | Q1. Major expected impacts are social, economic and environmental. Q2. Lack of information about social impacts (68%), economic impacts (69%) and risk reduction measures (51%). Q3. Disaster risk is not fully considered in sectoral planning (65-81%) -see P2-. Q10. Majority have experience in major storm surge flooding (86%), 6% had major impacts. Q11. Location of living/working activities in potentially flooded area (57-64%). 55% feels somehow threatened. Q8. Compared to other daily issues, storm surge is not perceived as an urgent problem. No prompt action is perceived necessary. |
| <i>P2. Strengthening disaster risk governance requires fostering collaboration between institutions and participation of relevant stakeholders, as well as</i> | Q3. Lack of fully risk-informed decision-making in tourism (81%), spatial planning (72%), location of critical and transport infrastructures and environmental protection (65-67%). Q7. Main authorities in charge of storm surge DRM processes are correctly identified. Confusion regarding responsibilities and mandates. Q12. Participatory DRM is preferred by 50%. More than half of them believe they can actively contribute with their knowledge and actions. |

| | |
|---|--|
| <i>integrating risk knowledge within sectoral decision-making and sectoral interests within DRM.</i> | Q13. Preparedness pro-active behaviour exists (80%). High authorities support (62%). Q16. Some stakeholders currently active in DRM have been identified. Q17. Lack of consensus regarding the involvement of sectoral and environmental stakeholders as well as some authorities in DRM partnerships. Q18. Partnership benefits: collaboration (20%), long-term strategies (18%), integration of all interests (13%). Partnership challenges: effective implementation of decisions (25%), proper collaboration (21%), and people's time (16%). Q19. Willingness to participate in a partnership at the present (84%); in the future (14%). |
| <i>P3. Public and private investment in DRR through structural and non-structural measures is essential.</i> | Q14. Preparation measures undertaken: temporary (25%), permanent (24%, lack of support of authorities perceived), insurance (10%, lack of support by insurance in Schleswig-Holstein). Q20. None of the economic instruments received high acceptance. Most accepted: incentives/compensation, grant/subsidies. Less accepted: catastrophe bonds, service concessions, land use taxes, and public contracts. |
| <i>P4. Enhancing disaster preparedness for effective response requires developing the various preparedness, response and recovery issues, as well as ensuring capacities are in place</i> | Q2. Lack of information about risk reduction measures (51%). Q3. Disaster preparedness is not integrated in sectoral planning (65-81%) -see P2-. Q5. Lack of information on availability of preparedness/recovery options (63%). Very high number of contradictory answers. Lack of knowledge about economic instruments. Q6. Warning mechanisms are well known. Q4. Flood protection: soft measures - coastal nourishment, building codes, coastal setbacks- are perceived less effective (34-55%) than hard measures - dykes and flood gates- (79-94%). Q9. Emergency procedures, teams and authorities receive lower trust levels (30-35%) than coastal defenses (70-90%). |

529

530 The major findings of the study regarding DRM information and stakeholders' perception,
531 perceived risk and adoption of protective behaviour, community preparedness and intention to
532 collaborate, and the feasibility of enhanced coordination and coordination schemes are
533 presented next.

534 *DRM information and stakeholders' perception:* the stakeholders identified a lack of
535 information regarding various DRM issues, more precisely those regarding the major expected
536 storm surge impacts in the area: economic, infrastructural and social impacts. The results also
537 show a lack of information regarding preparedness/recovery options such as evacuation
538 planning, temporary shelters and economic instruments. There is some knowledge on the
539 authorities involved in the DRM processes; however, the specific responsibilities and roles are
540 not sufficiently clear. Enhancing disaster preparedness (Sendai Framework, Priority 4) requires
541 developing the various preparedness, response and recovery processes the stakeholders were
542 asked about, as well as ensuring capacities are in place. Even though the study area has
543 implemented several successful initiatives and systems, full knowledge of these systems has not
544 been acquired by the society. DRM policies and initiatives should be based on a comprehensive
545 understanding of disaster risk (Sendai Framework, Priority 1). The results obtained suggest a
546 need for an improved communication strategy not based solely on information provision, but
547 able to reach every type of stakeholder according to their different needs, paying special
548 attention to specific topics and sectors. This would help meet society's expectations, increase
549 risk awareness and foster community preparedness options and proactive behaviours.
550 Additionally, a lack of sectoral interlinkages and information sharing between those who
551 manage the risk and those sectors which are exposed is also observed, as sectoral planning does
552 not fully consider storm surge risk. Strengthening disaster risk governance (Sendai Framework,
553 Priority 2) requires enhancing collaboration between institutions, as well as integrating risk
554 knowledge within sectoral decision-making and sectoral interests within DRM. Mainstreaming
555 and integrating DRR within and across sectors provides an opportunity to better protect society,
556 livelihoods, environment and assets.

557 *Perceived risk and adoption of protective behaviour:* even though risk is perceived and most
558 stakeholders had experienced at least one major storm surge flooding during their life, the

559 success of the coastal protection system in the past and the low frequency of events may affect
560 the readiness and intention to prepare. Compared to other daily problems, storm surge is not
561 perceived as an urgent issue to deal with, nor is prompt action perceived as necessary.
562 Therefore, it is supposable that only basic protective measures take place. The trust in hard
563 coastal protection measures is much higher than in soft measures, authorities and teams. A
564 “safety feeling behind the dykes” is perceived from the stakeholders’ answers that, together with
565 the lower trust in some DRM options and competencies, could hinder the adoption of additional
566 protective behaviours by the society. The uncertainty related to the success of the current dykes
567 in future climate scenarios requires reconsidering the current “safety feeling behind the dykes”
568 in order to shift towards increased risk awareness and the adoption of additional protective
569 behaviours. At this point the results clearly show that strengthening disaster risk governance not
570 only requires enhanced collaboration and integration of risk knowledge within sectoral decision-
571 making and sectoral interests within DRM (Sendai Framework, Priority 2) but also requires
572 enhanced consideration of the historical and cultural frames shaping stakeholder’s and society’s
573 behaviour. Besides this aspect, an improved communication strategy that engages the society in
574 debates, information sharing and capacity building would foster receptiveness of provided
575 information and support protective initiatives by improving society’s knowledge and awareness,
576 and adjusting to reality the trust and acceptance of the various flood protection options.

577 *Community preparedness and intention to collaborate:* there is some willingness and attitude
578 towards participative approaches, and the bases for engaging the community are set, however,
579 the private sector and sectoral associations do not feel fully involved. According to De Guzman
580 (2003), the multi-sectoral facet of community-based activities reinforces local organizations,
581 and enhances consciousness, awareness and critical appraisal of disaster risks and their inter-
582 dependence. To foster community-based adaptation initiatives it is important to move from
583 basic participatory approaches, based solely on information provision, towards full involvement
584 and collaborative approaches. Institutional support of community participation as well as
585 empowering community members in the process (Sendai Framework, guiding principles) could
586 be improved to enhance the intentions and expectations of society to collaborate. There are
587 already several stakeholders who are active in DRM at the local level in the study area, and who
588 could serve as leverage for participatory and collaborative approaches. Local-level institutions
589 and self-organization are critical for social learning, innovation, and action, all of which are
590 essential elements for local risk management and adaptation (Cutter et al., 2012). Besides the
591 participatory patterns, the society’s current preparedness behaviour is high, with 80% of the
592 respondents showing a pro-active behaviour at different levels. Out of those who are already
593 doing something to protect themselves, most of them think that their interests and actions are
594 included in DRM and planning, even though the results also show a general demand for
595 institutional and insurance support to enhance and facilitate the adoption of site-specific and
596 plausible preparedness measures. Besides, there is major reluctance against most types of
597 economic instruments. Public and private investment in DRR through structural and non-
598 structural measures (Sendai Framework, Priority 3) requires allocating resources for DRR
599 planning in all relevant sectors – which connects to Priority 2 –, promote economic mechanisms
600 for both public and private investments, and integrate DRR considerations in financial and fiscal
601 instruments, among other initiatives.

602 *Enhanced coordination and coordination schemes:* in general, a willingness to collaborate can
603 be observed, with 84% of the respondents stating that they personally or their organization
604 would participate in a DRM partnership since increased collaboration between stakeholders, the
605 possibility to develop long-term strategies and the consideration of the interests of all parties are

606 considered the main expected benefits. However, collaboration between stakeholders and long-
607 term effective implementation of initiatives are also highlighted as the main challenges, which
608 suggests that these benefits are usually not achieved, therefore requiring an extra effort to make
609 such a partnership feasible and worthwhile. When asked about the composition of such a
610 partnership, there is largely a consensus on the involvement of those stakeholders related to
611 coastal protection and emergency. However, the involvement of sectoral and environmental
612 stakeholders counts with the highest number of disagreements. DRR requires an all-of-society
613 engagement and partnership (Sendai Framework, guiding principles). Capacity building and
614 awareness campaigns about the relevance of this integrated approach should be promoted to
615 achieve improved coordination and collaboration schemes fully involving the public and private
616 sectors, and civil society organizations.

617 **4. Conclusions**

618 The German North Sea coast, just as many other locations worldwide, is exposed to natural
619 hazards such as storm surges and has been hit by several disastrous events in the past. The
620 current coastal protection system, together with the established governmental risk management
621 structure, has effectively and successfully reduced the impacts of contemporary events.
622 However, the sea level rise and its expected intensifying effect on storm surge events will
623 certainly affect coastal systems and low-lying areas in terms of increased submergence, coastal
624 flooding, and coastal erosion. A need for improved DRM is therefore not justified by a current
625 unsuccessful management but by a future increased risk due to climate change.

626 Guidance to improve DRM, also in consideration of climate change, is given by the Sendai
627 Framework (UN/ISDR, 2015). It assigns the States the primary responsibility to prevent and
628 reduce disaster risk, and suggests guiding principles and priority actions. However, the broad
629 scope of DRM makes it complicated to identify what processes should be improved and how to
630 accomplish it. In order to meet this challenge, the method applied in this work has proven to
631 provide a diagnosis of the study area as a starting point to meet the Sendai principles, by
632 identifying both strengths to maintain, and weaknesses to target and minimise when designing
633 further DRM initiatives.

634 From a methodological perspective, the presented study delivered important insights. As far as
635 sample representativeness is concerned, the comparison between the results obtained for the
636 pilot study, which covered an 85 km long stretch of coast with the inputs from 16 stakeholders
637 (Gonzalez-Riancho et. al., 2015) and those obtained for the whole German North Sea coast with
638 a sample of 116 stakeholders, showed large similarities between small- and large-scale
639 locations. We attribute this development in essence to the positive effect of careful compilation
640 of survey participants for which the extensive phase of contacting all participants and personally
641 introducing the survey matter had been crucial. The analysis of answers by location in the
642 present work showed very similar behaviour between the Lower-Saxony and Schleswig-
643 Holstein answers, which was partly unexpected due to different flooding episodes and different
644 management authorities and mechanisms. This, on the one hand, allowed generating results and
645 conclusions by type of stakeholder that can be extrapolated to both locations. On the other hand,
646 it highlights the effectiveness of the method in the identification of common patterns and
647 behaviours to be tackled in future DRR measures. Finally, the simple transferability and
648 adaptation of the questionnaire to other locations and hazards is a major advantage of the
649 framework and emphasizes the replicability of the method.

650 What we can learn from the German North Sea coast community is that institutionalisation and
651 centralisation after the 1962 incident has immensely improved storm surge protection
652 management. There is justified deep trust in the existing measures and schemes, reflected in the
653 widespread safety-feeling-behind-the-dykes. However, the shift towards higher level
654 responsibility reduced the local involvement and in the end narrowed the preparedness and the
655 intention to act among the local population. An enhanced sense of safety leads at the same time
656 to a reduced alertness within the society. This situation may lead to a place-specific mental lock-
657 in which hinders further engagement in DRM or prevents from engagement in necessary
658 adaptation measures. These lock-in situations¹⁹ hamper the development of new and innovative
659 measures of risk management.

660 While acknowledging the successful past and ongoing initiatives in the study area, the method
661 allowed the identification of several new societal challenges to deal with in order to enhance the
662 preparedness. The development of an improved risk communication strategy to effectively
663 exchange information and opinions between decision-makers and citizens across the full cycle
664 of disaster management has been identified as the way to increase knowledge, awareness,
665 credibility, trust and collaboration. Mainstreaming and integrating DRR within and across
666 sectors has been found to be essential to ensure administrative coordination, coherence across
667 sectoral plans and policies, and a better protection for society. The transition from basic
668 participatory approaches based solely on information provision towards full involvement and
669 collaborative approaches would enhance the support for and acceptance of political decisions,
670 the feeling of shared responsibilities and the full engagement of society.

671 The lessons learned from the case study reflect risk management issues that are common to all
672 parts of the German North Sea coast as well as to other coastal areas: lack of effective and
673 inclusive risk communication strategies, lack of coordination schemes and the safety-feeling-
674 behind-the-dykes. These crucial elements have to be taken into consideration in a successful
675 future oriented DRM. The results and discussion presented in this paper may therefore be useful
676 for the design of further DRR measures in the area as well as for others hazardous coastal
677 locations. A proper preparedness and adaptation requires not only ensuring that protection
678 systems are valid for future climate scenarios but also enhancing the societal characteristics that
679 condition the adoption of protective behaviours. Our results emphasize the need for jointly
680 strengthening social and institutional capacities towards improved risk management.
681 Recognizing institutional and social/individual abilities, as well as fostering full involvement
682 and appreciative collaborative approaches can significantly facilitate putting the Sendai
683 Framework successfully into practice.

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¹⁹ A lock-in describes phases where the learning processes within the system have become stagnant. The system stays in a state with partly inefficient patterns of behaviour and lack of innovation leading to greater vulnerability (Weig, 2016)

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