

21 **Table of Contents**

22 List of Tables..... 4

23 List of Figures 5

24 List of Equations 10

25 Abstract 11

26 Introduction..... 12

27 Background..... 12

28 Objectives 14

29 Significance..... 14

30 Limitations..... 15

31 Methodology 16

32 Theoretical Framework 16

33 Integrated risk management 16

34 Landscape approach 20

35 Urban resilience 25

36 Conceptual Framework..... 26

37 Location 30

38 Data Collection..... 32

39 Data Analysis 33

40 Findings 35

41 Hazards..... 35

42 Hydrometeorological 36

43 Geological 49

44 Technological..... 54

45 Environmental 58

46 Biological 58

47	Assessment	59
48	Vulnerabilities and Capacities	59
49	Socio-economic	59
50	Environmental	67
51	Infrastructural	73
52	Governance	81
53	Analysis	91
54	Worst-case scenario	91
55	Urban resilience	91
56	Landscape approach	96
57	Integrated risk management	99
58	Conclusions	101
59	Recommendations	103
60	References	104

61 **List of Tables**

62	Table	Page
63	1. Projected seasonal temperature increase in Metro Manila in the next 15-45 years given a	
64	mid-range emission scenario. All values in °C. Source: PAGASA (2011).....	45
65	2. Poverty incidence among families in cities along the MANATUTI river system. Source:	
66	PSA (2015, 2018)	59
67	3. Percent poor in cities along the MANATUTI river system. Source: NHTS-PR (2017).....	60
68	4. Percentage of poor individuals age 15 and above with no reported occupation.....	61
69	5. Dominant industry in terms of number cities along the MANATUTI river system	62
70	6. Ground water extraction persistence and availability of potable water to the urban poor	
71	along the MANATUTI river system	63
72	7. City health attendance data.....	65
73	8. Number of hospitals, health centers and bed capacity ratio of cities along the MANATUTI	
74	river system	66
75	9. Water quality parameters measured by DENR along the MANATUTI river system.	
76	Source: DENR Water Quality Monitoring Report MANATUTI WQMA	68
77	10. Number of materials recovery facilities and diversion rate of cities along the MANATUTI	
78	river system	72
79	11. ICT platforms utilized by cities along the MANATUTI river system as warning system ..	80
80	12. Proposed reclamation projects associated with the MANATUTI landscape	86

81 **List of Figures**

82	Figure	Page
83	1. The integrated risk management framework and its major components.....	18
84	2. The integrated risk management framework and its key elements	19
85	3. The landscape approach views the environment as consisting of both geo-ecological and	
86	socio-economic layers	21
87	4. The landscape approach views disaster across multiple spatial scales	24
88	5. Diagrammatic representations of the two traditional types of resilience: (L) engineering,	
89	which refers to the ability to return to the same stable equilibrium and (R) ecological,	
90	which is concerned with withstanding shock and arriving at a new, different equilibrium	
91	state	25
92	6. The urban resilience framework, its key elements, and their interrelationships.....	28
93	7. The urban resilience framework with special focus on the most vulnerable group in the	
94	system, the urban poor	30
95	8. Location of the MANATUTI river system its surrounding communities in northern Metro	
96	Manila (inset). Source: Google Earth (2020)	31
97	9. Flood risk map of northern Metro Manila, showing most flood-prone areas for 2 to 10-	
98	year flood cycle (yellow) and 50 to 100-year flood cycle (purple). Notice the very flood-	
99	prone western half of MANATUTI covering Navotas, Malabon, Manila, and the western	
100	portion of Valenzuela. The outline of the MANATUTI river system (labelled Tullahan	
101	River) can also be seen. Source: DENR Mines and Geosciences Bureau Lands Geological	
102	Survey (2009)	37
103	10. Flood vulnerability map of northern Metro Manila. Notice the consistently flood-prone	
104	western CAMANAVA. The outline of the MANATUTI river system is conspicuous at a	
105	very high frequency flood vulnerability. Source: Pornasodoro et al. (2014)	39

106	11. Disaster risk map of northern Metro Manila due to flood, taking into account	
107	demographic and household characteristics of communities. Notice the consistently	
108	flood-prone western CAMANAVA. The outline of the MANATUTI river system is	
109	conspicuous at a high risk grade. Source: Pornasodoro et al. (2014)	40
110	12. Typhoon frequency across the greater part of Luzon, showing relatively high typhoon	
111	incidence for Metro Manila. Source: DENR & Manila Observatory (2018)	41
112	13. Trends in the frequency and intensity of tropical cyclones that enter PAR since the	
113	1950s: (a) annual number of tropical cyclones, (b) downward trend in the total number	
114	but upward trend in the number of very strong tropical cyclones, (c) increase in the	
115	number of strong tropical cyclones in the past almost two decades. Source: PAGASA	
116	(2018)	42
117	14. Inundation map of northwestern Metro Manila showing the Navotas and Manila coasts	
118	and inland western Malabon to be submerged in 1-4 m flood following a worst case	
119	storm surge-inducing typhoon in the West Philippine Sea. Source: Lapidez et al. (2015)	
120	44
121	15. Temperature change trend in the Philippines per decade from 1951-2015: (a) change in	
122	mean annual temperature, (b) change in minimum temperature, (c) change in maximum	
123	temperature. Source: PAGASA (2018)	45
124	16. Rainfall change projection in the Philippines in the next 16-45 years from highest	
125	increase (wettest) to highest decrease (driest). Notice the consistent relative increase in	
126	precipitation in Metro Manila and CALABARZON. Source: PAGASA (2018)	47
127	17. Sea level increase in Metro Manila through the years. Source: PAGASA (2018)	47

128 18. Sea level change projection until 2100: (a) following measurements from tide gauges in
 129 Bicol and Cebu since 1960 given a high-emission scenario, (b) global projection under a
 130 mid-emission scenario, (c) global projection under a high-emission scenario. Source:
 131 PAGASA (2018).....48
 132 19. Sinking of the western portion of MANATUTI is predicted by 2050 due to sea level rise
 133 brought by accelerated global warming. Source: Climate Central (2019)48
 134 20. Ground subsidence rate in northern Metro Manila. Notice the disparate velocity of
 135 subsidence in the western MANATUTI relative to other parts of the region. Source: Eco
 136 & Rodolfo (2018)49
 137 21. Location of Metro Manila in relation to the two most significant geologic structures that
 138 cause seismic movements in the region, the Manila Trench (purple) and the Valley Fault
 139 System (red). Source: PHIVOLCS (2000).....50
 140 22. Ground shaking hazard map for northern Metro Manila in the event of a M6.5 (left) or
 141 M7.2 (right) West Valley Fault earthquake. Intensity 7 to high 8 will be felt along
 142 MANATUTI, with greater intensity along the coast. Source: PHIVOLCS (2014)51
 143 23. Liquefaction susceptibility map of northern Metro Manila. Notice the high (red) and
 144 moderate (purple) susceptibility of coastal MANATUTI. Source: PHIVOLCS (2014).....51
 145 24. Population in western MANATUTI at risk to liquefaction following the Big One. Source:
 146 PHIVOLCS (2014)52
 147 25. Tsunami wave height map of northern Metro Manila following the Big One. Across
 148 coastal MANATUTI, notice the higher inundation in Navotas and Malabon relative to
 149 Caloocan and Manila. Source: PHIVOLCS (2013)53
 150 26. Vulnerability characteristics of northern Metro Manila to other earthquake-induced
 151 hazards. Notice the high comprehensive vulnerability of western MANATUTI (red).
 152 Green – high evacuation difficulty, orange – high flammability. Source: MMEIRS (2004)
 15353

154 27. Regional separation of western and eastern MANATUTI according to comprehensive
 155 vulnerability to earthquake. Green – low risk, yellow – moderate risk, orange and red –
 156 high risk. Source: MMEIRS (2004)54
 157 28. Fire hazard map of northern Metro Manila showing the high flammability of western
 158 MANATUTI, especially Navotas, Malabon, Caloocan, and Manila. Source: MMEIRS (2004)
 15955
 160 29. Comparative waste generation rate between cities in northern Metro Manila. Quezon
 161 City and Manila generate the highest amount of solid waste per day as of 2018. Source:
 162 DENR EMB (2019).....56
 163 30. Building damage projection for northern Metro Manila given a Big One scenario. Notice
 164 the moderate (yellow) to high (orange and red) risks along the western portion of
 165 MANATUTI, with the eastern portion is at low risk (green and blue). Source: MMEIRS
 166 (2004)57
 167 31. DENR Sampling sites for water quality monitoring along MANATUTI.....68
 168 32. Annual mean standard deviation ($\mu \pm SD$) of Biological Oxygen Demand (BOD) and
 169 Dissolved Oxygen (DO) along the MANATUTI river system for 2017-201870
 170 33. Relatively spread readings for all the plots (all coefficient of variation [CV] ≥ 1) also
 171 indicate a large variation between the monthly reading of DO and BOD for 2017 and
 172 2018.71
 173 34. Pumping Station and Flood Gate distribution of Major flood mitigation projects along the
 174 MANATUTI river system74
 175 35. More than 44 bombastiks are now distributed in the barangays of Navotas77
 176 36. Map of the early warning systems for the Tullahan River Basin (Peralta, 2016)79
 177 37. Interface of the HazardHunterPH. Source: GeoRisk (2019)80
 178 38. Administrative boundary of the MANATUTI WQMA82
 179 39. There is a significant difference in both the means of BOD and DO for the 1st half of 2019
 180 and in 2018 for the same period.85

181	40. Reclamation projects associated with portions of the MANATUTI river system. Source:
182	Philippine Reclamation Authority (2018)86

183 **List of Equations**

184	Equation	Page
185	1. Symbolic equation for disaster risk in integrated risk management	16

186 **Abstract**

187 Despite the wealth of data about disasters in Metro Manila, no dedicated study has holistically
188 examined the risks associated with the Malabon-Navotas-Tullahan-Tinajeros river system
189 (MANATUTI), especially in an urban landscape perspective. A pilot risk assessment of the river
190 system was conducted using the integrated risk management, landscape, and urban resilience
191 approaches. Document analyses, key informant interviews, focus group discussions, and field
192 visits were done to identify and analyze the hazards that pose threats to the communities along
193 MANATUTI, especially the urban poor, and how vulnerabilities aggravate and capacities
194 mitigate these risks, especially in the socioeconomic, environmental, infrastructural,
195 institutional, and governance aspects of the river system. Communities in the river system face
196 severe risk to compound hazards such as flooding exacerbated by ground subsidence, sea level
197 rise, and storm surge, fire and liquefaction resulting from earthquake, and public health
198 outbreaks made favorable by increasing temperature, environmental pollution, and congestion,
199 among others. These are worsened by extreme poverty and powerlessness of the greater
200 population and the highly fragmented urban planning and risk management efforts in the
201 landscape. Nevertheless, the inclination of the communities toward collaboration and
202 transformation, alongside expansive rooms for improved governance, are important capacities
203 that may enhance their resilience to disaster. A formal, well-supported, landscape-wide, inter-
204 community governing institution that practices equitable distribution of responsibilities and
205 resources is deemed essential to realize a comprehensive and effective disaster risk reduction
206 and management in the river system in the face of rapidly changing climate and environment.

207 **Keywords:** climate change adaptation, ecosystem management and restoration, disaster risk
208 reduction, integrated risk management, landscape, urban resilience

209 **Introduction**

210 *Background*

211 The northern district of Metro Manila has always been prone to massive flooding not only due
212 to its geophysical characteristics and high urbanization rate but also to river flooding, as
213 exacerbated by increasing rainfall and the continuous degradation of its major water body, the
214 Malabon-Navotas- Tullahan-Tinajeros river system (MANATUTI) (Philippine Institute of
215 Volcanology and Seismology [PHIVOLCS], 2008; Philippine Atmospheric, Geophysical, and
216 Astronomical Services Administration [PAGASA], 2011; Census of Population [POPCEN], 2015;
217 Department of Environment and Natural Resources [DENR], 2018, 2019). MANATUTI drains the
218 La Mesa Watershed in Quezon City, traverses the cities of Caloocan, Malabon, Navotas, and
219 Valenzuela (CAMANAVA) westward, and opens into the Manila Bay along Navotas and
220 northwestern Manila. Together with the other major river systems in Metro Manila, it has
221 contributed to several significant flooding events in the capital region, including two of the
222 worst, the Great Flood of 1972 and typhoon Ondoy (Ketsana) in 2009, the latter leaving some
223 150,000 people in the whole region homeless (Time, 2009; Gonzales-Noda & Aid, 2012;
224 Francisco, 2017; Ragodon, 2019).

225 Prompted by the need to extend its expertise and advocacy in disaster resilience to the urban
226 region, the Partners for Resilience (PfR), a global alliance of Netherlands-based humanitarian,
227 development, and environmental organizations funded by the Dutch Ministry of Foreign Affairs,
228 expanded their rural work in the Philippines to vulnerable communities in CAMANAVA from
229 2011 to 2015 (PfR Indonesia and Philippines, 2014). Together with its local social development
230 partners CARE Philippines and the Assistance and Cooperation for Community Resilience and
231 Development, Inc. (ACCORD), PfR has done comprehensive disaster resilience work with the
232 communities in the district, with main focus on disaster mitigation, climate change adaptation,
233 and environmental restoration, especially around MANATUTI (PfR, 2016). In 2014, PfR

234 commissioned a comprehensive literature review on the Tullahan river, one of MANATUTI's
235 main tributaries, for a more informed plan on a comprehensive risk management program in
236 the river system. The review concluded that "ecosystem degradation and community
237 disintegration coupled with uncoordinated disaster risk reduction measures in the area have
238 become largely responsible for several flooding events in northwestern Metro Manila, severely
239 affecting lives, properties, and the environment" (Mancera et al., 2014). A few more years later,
240 PFR ventured into the second phase of its disaster resilience work in the area, this time, in policy
241 dialogue to strategically incorporate disaster risk reduction, climate change adaptation, and
242 ecosystem management and restoration, to the local government units' plans, alongside the
243 private sector, other civil society organizations, and the communities (PFR, 2016).

244 However, along the new chapter of disaster resilience work in the district came more adverse
245 scenarios that pose further threats to the safety and livelihood of its citizens. Flooding has
246 worsened in the region. In fact, from an average of 18.5-minute subsidence period, it went as
247 long as 30 minutes from 2018 to 2019, and from strictly typhoon in origin to simply increased
248 torrential rains during the wet season, thereby increasing the potential damage to lives and
249 properties (Business Mirror, 2019). This is alongside more frequent and recent incidents of
250 earthquake, fire, and health outbreaks.

251 With climate change and urbanization in the region that remain unchecked, a more
252 comprehensive disaster risk management in the district in the near future is imperative.
253 However, such requires a well-formulated initial risk assessment to determine what existing
254 information about hazards, capacities, and vulnerabilities in the district there is and what gaps
255 need to be filled. For a district that faces mostly water-related hazards such as flooding, this
256 assessment begs a landscape-wide examination. However, for a highly populated and
257 industrialized region where most water resources no longer come from its main water bodies
258 due to severe environmental degradation, an urban-specific approach to the landscape-wide
259 assessment is deemed necessary (Trovato et al., 2017; Yuan et al., 2019).

260 *Objectives*

261 Generally, this study sought to assess the risks present around the MANATUTI river system
262 using the integrated risk management and landscape approaches, and urban resilience
263 framework. Specifically, it aimed to:

- 264 1. Identify the main hazards present in MANATUTI and analyse their interrelationships;
- 265 2. Identify the main vulnerabilities and capacities of the communities in MANATUTI and
266 analyse them according to the urban poor resilience framework;
- 267 3. Determine the worst-case scenarios and analyse the interrelationships between the
268 hazards and vulnerabilities and capacities of the communities in MANATUTI; and
- 269 4. Identify gaps and synergies in MANATUTI as an urban landscape for future risk
270 management plans.

271 *Significance*

272 This study is an important preparatory work in the planning and conduct of an integrated,
273 landscape-wide, and urban poor-oriented risk management program in MANATUTI. It provides
274 both technical and social information that may serve as a springboard for future development
275 programs of both local and international civil society organizations, especially those that
276 champion the principles of disaster risk reduction, climate change adaptation, and ecosystem
277 management and restoration. It provides a synthesis of relevant literature that may serve as
278 starting material for local and international academic and research institutions, especially those
279 doing urban and resilience studies to continue and improve. It provides the different levels of
280 government in Metro Manila, in the entire country, as well as abroad, informed alternatives and
281 evidence-based development options for their public service programs. Finally, it serves as a
282 compendium of experiences that reflects the built resilience of the communities in MANATUTI
283 and lessons to reflect on to further safeguard their collective safety and welfare.

284 *Limitations*

285 This risk assessment is limited to qualitative methodologies, i.e., the use of written and oral
286 accounts to assess hazards, vulnerabilities, and capacities in MANATUTI. Technical and
287 quantitative methods such as GIS-based cartography and systematic surveys are yet to be
288 carried out. In interviews and focus group discussions, persons below 18 and above 60 were
289 excluded due to limitations in securing further clearance from ethical review boards. The
290 conduct of the study was also halted considerably by the 2019 midterm elections, which
291 effectively changed the political composition and landscape in many local government units and
292 executive agencies.

293 **Methodology**294 *Theoretical Framework*

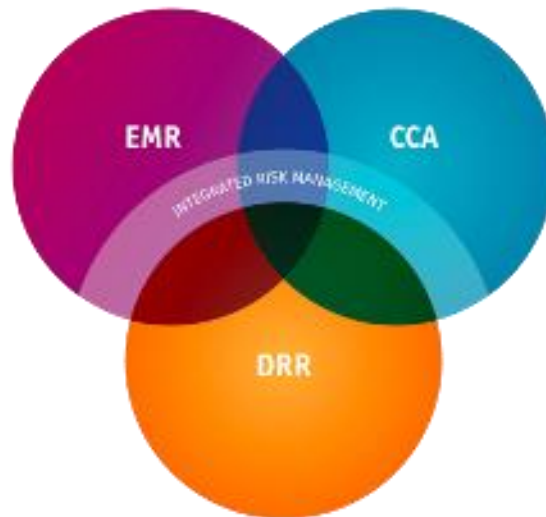
295 **Integrated risk management.** Integrated risk management (IRM) is a comprehensive
 296 approach to disaster resilience, which covers traditional disaster mitigation, preparedness, and
 297 prevention, but one that considers how climate change increases hazard unpredictability and
 298 intensity and how healthy ecosystems can improve resilience to disasters (CARE, 2017). In IRM,
 299 disaster risk is determined by the conventional symbolic equation, that is, the magnitude of
 300 hazard is amplified by the vulnerabilities of the people exposed to it, but is ultimately reduced
 301 by both built and introduced capacities in the area (Eq. 1). Therefore, disaster risk reduction
 302 (DRR) is best realized by boosting the capacities of the people using both their traditional
 303 knowledge and external reinforcements. However, in this traditional definition, DRR is only as
 304 good as the certainty of occurrence of hazards and their magnitude.

$$\text{Disaster risk} = \frac{\text{Hazard} \times \text{Vulnerability}}{\text{Capacity}} \quad (\text{Eq. 1})$$

305 Disturbing events in nature now come with disturbing trends (Wardekker et al., 2009). With the
 306 ongoing accelerated climate change, the predictability of hazard and its intensity decreases.
 307 Therefore, DRR programs must attune to expected climate projections, preferably within both
 308 short and long time frames. While conventional DRR has long focused on abrupt but foreseen
 309 hazards, climate change adaptation (CCA) largely considers slower onset environmental
 310 changes. When applied to vulnerable communities, CCA then aims to find alternative methods
 311 for their vital social activities that are climate-sensitive. For example, because climate change is
 312 generally atmospheric, most hazards affected by climate change are hydrometeorological, and
 313 so outdoor and environment-based livelihoods that are water- and water-sensitive may be
 314 programmed to adjust to these changes. Another notable principle in CCA is that aside from

315 seeking buffers to harms brought by hazards, it may also maximize opportunities from climate
316 change, if any (Intergovernmental Panel on Climate Change [IPCC], 2014). This may include
317 harnessing water energy from excess rainfall or heat energy from increased temperatures,
318 among others. Finally, because climate change is informed by science, CCA is supposed to bridge
319 the general public and the scientific community. An effective DRR with CCA assures lay people
320 that technical principles behind climate change are relayed to them in the most comprehensible
321 manner possible.

322 Finally, humans extract resources from the environment, both for personal sustenance and vital
323 social activities. With rapid changes in population concentration in an area and corporate over-
324 tapping in others, to name a few factors, the acquisition of natural resources is accelerated. This
325 over-extraction inevitably lowers the quality of natural ecosystems. In DRR, ecosystem
326 degradation may serve a dual role—lower the capacities and become the very vulnerability of
327 communities exposed to it, or become a hazard of its own—either way affects DRR strategies.
328 This is where ecosystem management and restoration (EMR) in DRR comes in. Countering
329 environmental degradation, EMR increases the capacity of the community by providing natural
330 assets for community consumption and livelihood or reduces their vulnerability to hazards by
331 buffers or barriers against them. It recognizes the need for responsible extraction from nature
332 and takes into account its natural pace of recovery. EMR is also best conducted on a landscape
333 scope, which means it recognizes, for example, the effects of the situation upstream to
334 downstream and vice versa and works with the broadest and most diverse stakeholders to
335 ensure maximum participation in the delivery of maximally effective programs.



336

337

Figure 1. The integrated risk management framework and its major components.

338

The IRM framework analyzes the elements of disaster response in a three-way manner: the

339

drivers of risk that introduce disturbance to a community, the existing capacities of the

340

communities that they use to respond to the disturbances, and their enabling environment that

341

enhances the disaster response. The drivers of risk include natural hazards that exist in the area

342

aggravated by climate change and ecosystem degradation. The capacities of the communities

343

are assets that they use to respond to disturbances and may be natural, such as forests and

344

watersheds, social, such as community cohesion and influence, physical, such as infrastructure,

345

human, such as people's skills and aspirations, and economic, such as savings and insurance

346

systems. The enabling environment, which enhances the disaster response, comprises

347

partnerships for good neighborliness in an area, that is between communities, civil society

348

organizations, private sector, and public authorities. Capable communities themselves are at the

349

top of the enabling environment, with a comprehensive understanding of IRM for decision-

350

making and capacities building. Capable civil society organizations provide technical and social

351

support to communities that are anchored on a comprehensive understanding of IRM

352

principles, equipped with training and advocacy materials. They also occupy a legitimate

353

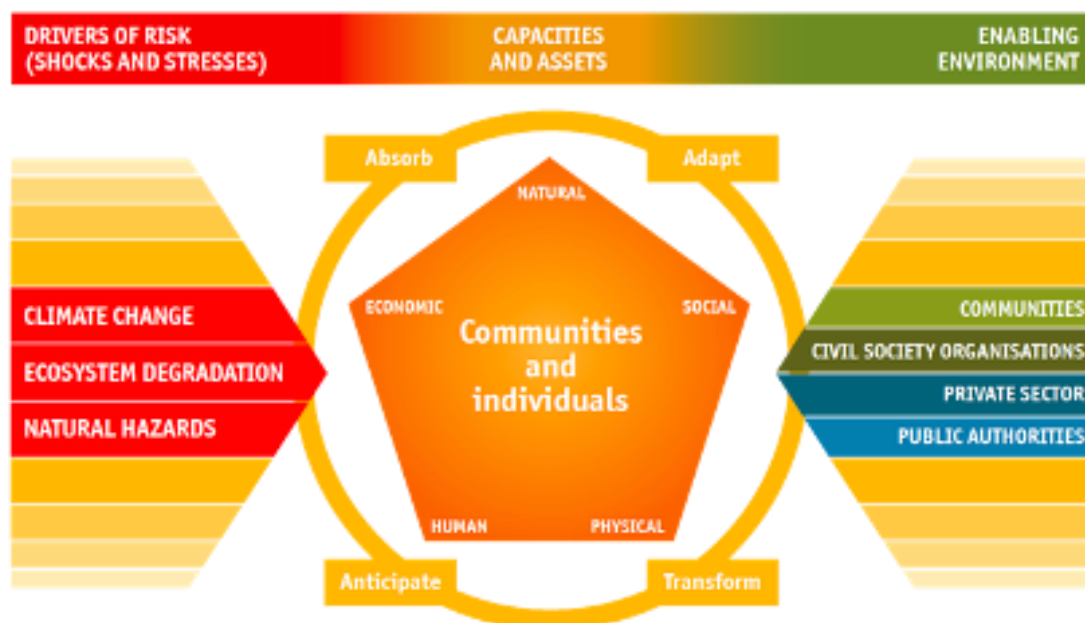
operating space within the communities and may hold governments accountable in cases of

354

deviation to plans. Responsible private sector creates opportunities and innovations in the

355 communities and not only actively incorporates IRM in their corporate social responsibilities
 356 but also intentionally advocates it in their daily sustainable practices. Finally, responsible public
 357 authorities have scientific expertise, exhibit proficiency in sustainability and law enforcement,
 358 treat national and local policies anchored upon IRM as investments, uphold commitment to
 359 international standards, assure that the communities take ownership of different risk
 360 management programs, and facilitate a democratic negotiation space for various stakeholders.

361 With the mentioned drivers of risk, people’s capacities, and enabling environment, the IRM
 362 framework ensures that the programs in the area are: anticipative, where impacts are reduced
 363 because they are foreseen, lessons are learned, and projections are science-based, and so are
 364 uncertainty- and surprise-robust, absorptive, where behaviors are changed to help communities
 365 swiftly recover, adaptive, where strategies are adjusted and livelihoods made flexible to
 366 changes, and transformative, where interactions within the community and the environment
 367 are ultimately changed to effect an enabling environment post-disaster.



368

369 *Figure 2. The integrated risk management framework and its key elements.*

370 Ultimately, IRM focuses on different kinds of hazards, especially those affected by climate
371 change and ecosystem degradation, and places communities and their capacities and assets at
372 the center of activities, while ensuring that disaster-mitigating solutions are nature-based and
373 their local livelihoods sustainable within the ecosystem they are in. IRM aims to reduce loss of
374 lives and livelihoods, especially by the most vulnerable, by providing communities with
375 capacities, assets, and enabling environment to anticipate, absorb, adapt, and transform before
376 natural hazards, exacerbated by climate change and ecosystem degradation.

377 **Landscape approach.** When applied to a particular risk-rich area, IRM is best practiced
378 through a landscape approach, that is, by looking at both the natural and social environment in
379 managing risks. Landscape approach was born out of the need to address areas as socio-
380 ecological systems, which consists of both natural and human features that affect each other.
381 Spaces are considered to comprise two layers: the geo-ecological layer, which consists of bodies
382 of water and their behavior, different soil types, ecosystems that exist, and climate setting,
383 whereas the socio-economic layer consists of people and formations with diverse and diverging
384 interests, decisions of whom affect the others directly or indirectly, the existing infrastructure,
385 livelihoods, economic activities, and ecosystem services that benefit the people.



386

387 *Figure 3. The landscape approach views the environment as consisting of both geo-ecological and socio-economic layers.*

388 The landscape approach evolved from the theories of conservation and metapopulation, where
389 areas were treated as islands, with the biogeographic components being regulated to service
390 and maintain viable populations, whether plants, animals, or humans. Later on, however, from a
391 purely ecological perspective, the need to address the priorities of people, the system behavior
392 of whom is not wholly predictable, was recognized and the socio-ecological systems framework
393 was born. This approach attempts to reconcile and fuse environmental conservation and social
394 development objectives, an integration of agriculture and conservation, production and
395 protection, environmental management and poverty alleviation (Sayer et al., 2012).

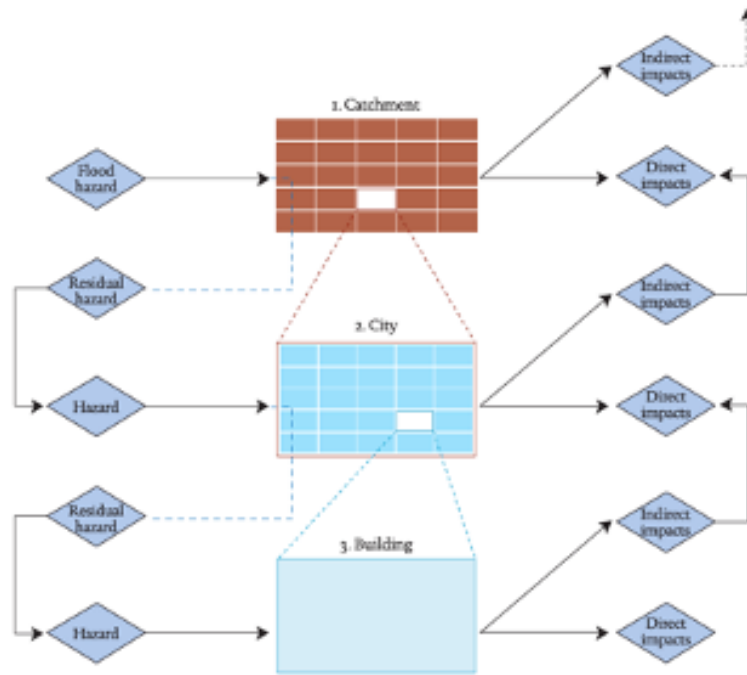
396 The landscape approach encompasses the natural and social resources horizons of an area. It
397 considers the entire breadth of the area, e.g., from the ridge to the reef, to create a sustainable
398 impact in all communities that acquire their natural resources from any or all parts of the
399 landscape. It also considers different communities as a single unit despite several
400 administrative boundaries and extra-sectoral constraints (Kusters, 2015). This means that it

401 works across traditional sectors, multiple stakeholders, government departments, and levels of
402 jurisdiction, and facilitates trade-offs between members of the communities while maximizing
403 opportunities for their synergies. It is worth noting that the landscape approach pays special
404 attention to marginalized groups. Therefore, the landscape approach is an integration of
405 conservation and development objectives at the landscape level, working across different
406 stakeholders, especially the vulnerable. For example, in an area with rich natural resources but
407 growing population and increasing poverty, a landscape approach fuses environmental
408 conservation-oriented perspectives and poverty alleviation goals. Finally, aside from the two
409 components that comprise the landscape, it also looks at risk management as a continuous,
410 iterative, learning process. This means that responses to risk in the area are improved based on
411 past and continuing experiences of people living in it. For example, for a landscape with huge
412 bodies of water and therefore water-dependent livelihoods, the approach gives importance to
413 the learned experiences of the people in times of drought and their ability to shift or transform
414 their livelihoods in preparation for more, similar incidents in the future.

415 Ultimately, therefore, landscape approach in IRM examines three elements and their
416 interrelationships, the natural resources, social resources, and adaptive processes linked to
417 these types of resources through time. For example, a landscape approach-informed DRR in an
418 area dominated by bodies of water includes an analysis of the hydrology of the area and takes
419 into account the catchment upstream to the area downstream, from higher spatial level to lower
420 spatial level. It also takes into account the communities around the water bodies and even
421 places them in the center, employs interdisciplinary, cross-sectoral, inclusive, and participatory
422 methods of linking them together, manages trade-offs and synergies between them, and
423 integrates ecosystem management and restoration to provide sustainable services for the
424 communities, especially their most vulnerable members. Finally, it renders plans in the area
425 flexible to future changes, such as those related to the changing climate, and therefore must be

426 creative and innovative so ripple or multiplier effects are reduced when facing future disasters
427 (Zevenbergen et al., 2008; Wardekker et al., 2009).

428 Three principles are common to all recent accounts proposing the landscape approach and are
429 applied to all actors in a landscape: adaptive resilience, cooperative stakeholders, and effective
430 governance. Adaptive resilience refers to the capacity of landscape members to learn
431 continuously, that means, glean lessons from surprise disturbances, apply them to either avoid
432 or deflect threats later or absorb them in case of a new disaster, allowing for recovery or
433 adjustments, or in cases of extreme disturbances, transformation while maintaining many
434 beneficial attributes of the local landscape (Kusters, 2015). Cooperative stakeholders refer to
435 members with shared objectives, interests, and visions for a multifunctional landscape, common
436 concerns which are the entry or starting point of any partnerships, but who also build
437 confidence and trust to successfully and continuously engage in tradeoffs and negotiations.
438 They facilitate participatory and constructive debates wherein competent and effective
439 representatives of multiple stakeholders reconcile their multiple needs while anchoring their
440 decisions on science and observing fundamental principles of equity and humanity such as fair
441 distribution of benefits and incentives, especially to the marginalized. Finally, effective
442 governance involves leadership that cuts across multiple scales, from higher to lower level
443 processes, with members of the body certain about their individual and collective rights and
444 responsibilities, with a democratically agreed upon system of rules for facilitation of
445 negotiation, arbitration, justice, and reconciliation.



446

447

Figure 4. The landscape approach views disaster across multiple spatial scales.

448

The first step in the landscape approach for IRM is an initial assessment of the risk landscape

449

that is carried out internally by the organization. This includes understanding the drivers of

450

risk, capacities and assets of communities, and their enabling environment. Problems such as

451

why and where disasters occur in the landscape, their impact on people, ecosystem, and

452

economies, the common concerns among multiple stakeholders that need to cooperate for full

453

but sustainable utilization of a multifunctional landscape, the set of democratic rules that

454

govern the landscape considering power relations, are explored. If done by a civil society

455

organization that has a shared vision for the landscape, this step also allows for an

456

organizational self-assessment, and whether a landscape approach is appropriate to pursue

457

based on the initial assessment. This is important to determine the broad spatial boundaries of

458

the landscape and basic outlines of a possible program. An initial risk assessment using a

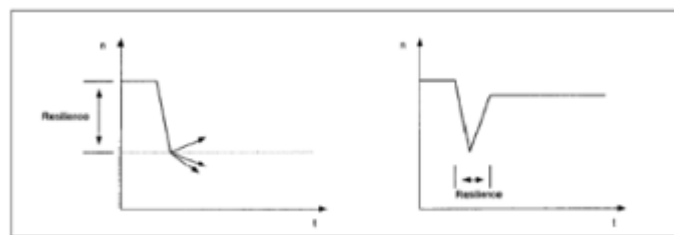
459

landscape approach is a sound investment as it forms the foundations upon which a more

460

comprehensive and effective IRM program may be based.

461 **Urban resilience.** Resilience is defined in physics as the ability to elastically deform under load.
 462 In complex systems (Wardekker et al., 2009), it means the ability to absorb disturbance and
 463 reorganize and still persist while undergoing changes. Traditionally, two types of resilience
 464 were recognized, engineering and ecological, the former referring to the ability to return to a
 465 previous, single, stable equilibrium, and is primarily concerned with recovery rate, while the
 466 latter, the ability to change its state towards a different equilibrium state, and is primarily
 467 concerned with withstanding shock without necessarily returning to its original form.



468

469 *Figure 5. Diagrammatic representations of the two traditional types of resilience: (L) engineering, which refers to the ability*
 470 *to return to the same stable equilibrium and (R) ecological, which is concerned with withstanding shock and arriving at a*
 471 *new, different equilibrium state.*

472 The concept of ecological resilience gained further support from DRR practitioners when the
 473 perspective shifted from purely natural to socio-ecological systems or the interaction between
 474 natural and human components. Now, resilience is considered as the ability of a socio-ecological
 475 system to anticipate threats and disturbances, adjust responses to them, create a fundamentally
 476 new system, continue developing, and prepare for more long-term improvements and
 477 transformations. This new understanding of resilience further reinforces the need for a
 478 landscape approach to disaster resilience.

479 Cities, however, are no basic landscapes. They are considered complex, autonomous systems
 480 that continuously change under pressure, often uncontrolled, and are therefore always far from
 481 equilibrium (Zevenbergen et al., 2008). Mostly a result of internal migration of people from
 482 rural communities, continuous and uncontrolled urbanization intensifies the vulnerabilities
 483 already inherent to urban areas (Stott & Nadiruzamman, 2014). First, cities are often located in

484 areas that are naturally prone to multiple hazards, the combination of which often pose a threat
485 to natural ecosystems that are already damaged by human pressures such as over-extraction
486 and pollution. Second, with the advent of accelerated climate change, most of these threats,
487 especially those that are weather-related, have also changed in frequency, severity, and
488 unpredictability. Finally, cities burst in development, but also have finite natural resources, and
489 so depletion of resources for consumption and sustenance of populations that depend on them
490 adds to the threats that make cities further vulnerable to disaster. Cities then become both
491 vulnerable and responsible, especially because of land use policies that overlook the mentioned
492 threats and pressures. For example, in cities that are formed close to large bodies of water,
493 unchecked urbanization typically results in the construction of unstable buildings in informal
494 settlements, competition for public services, and intensified pollution, which further strain the
495 lives and livelihoods of poor urban dwellers, resulting in their increased susceptibility towards
496 flooding (Zevenbergen et al., 2008).

497 These particular characteristics warrant the treatment of cities as urban landscapes with a
498 variety of dimensions, i.e., environmental, social, physical, economic, etc., affected by
499 heterogenous threatening factors such as combined hazards, climate change, and environmental
500 degradation, but still needs management as a whole. An urban landscape approach in IRM,
501 therefore, examines cities in a more systemic, multi-threat viewpoint, across different spatial
502 and temporal scales, is focused on reducing the dependence of communities to depleting
503 sources of energy, and gives priority to those who are most vulnerable to disasters, those living
504 under poverty threshold.

505 *Conceptual Framework*

506 Contextualization is crucial in IRM, especially in the initial assessment of the risk landscape. The
507 complexity of MANATUTI as an urbanized water system warrants the use of an equally complex
508 yet apt framework in analyzing the different hazards, vulnerabilities, and capacities that

509 surround the area. For this, the urban poor resilience framework, specifically developed by
510 MOVE UP Moving Urban Poor in the Philippines Towards Resilience, a project by PfR partners
511 CARE and ACCORD and the Philippine arms of international organizations Action Against
512 Hunger and Plan International in Metro Manila, will be used.

513 The urban poor resilience framework focuses on boosting the built capacities of the
514 communities in five closely interrelated aspects of an urban landscape: socioeconomic,
515 environmental, institutional, infrastructural, and governance, but with emphasis on the most
516 vulnerable sector, the urban poor. Building resilience among the communities in these five
517 aspects entails improving the social positions of the stakeholders as well as creating an enabling
518 environment for a continuous and sustainable IRM program.

519 The five aspects of the urban poor resilience framework are closely related to the main features
520 of a resilient city that are common to contemporary resilience studies: (1) learning capacity, an
521 intrinsic capacity that is ultimately dependent on the socioeconomic footing of the communities
522 in the landscape, (2) diversity, an extrinsic capacity dependent on the environmental assets that
523 are available for consumption and exploitation by communities, (3) robustness, a capacity
524 dependent on built infrastructure, (4) innovation, a capacity provided by peripheral institutions
525 to promote transformation of communities, and (5) efficiency, a capacity provided by central
526 governing bodies to facilitate risk management. In all of these capacities, how they build
527 resilience, improve social positions, and foster an enabling environment for a successful IRM
528 program need to be assessed (Stott & Nadiruzamman, 2014; Kusters, 2015).



529

530

Figure 6. The urban resilience framework, its key elements, and their interrelationships.

531

Learning capacity refers to the capacity of the communities to derive lessons from past events, reflect on their impact, and consequently adjust future responses to improve existing systems.

532

In IRM, this means being able to anticipate or foresee impending risks and deal with their

533

uncertainties, study their causes and interrelationships, and use this awareness to cope in

534

future disasters to come. In an urban setting, ultimately, learning capacity is a function of the

535

socioeconomic status of community members, with the urban poor, especially the children,

536

women, and elderly sectors who have a greater lack of autonomy, at the core. Assessing the

537

learning capacity of the community requires active participation of citizens, not just for initial

538

assessment, but to foster ownership of the IRM program in the future.

539

540

Diversity is an extrinsic capacity of communities that is closely associated with the quality of

541

their environmental resources. In IRM, this means being able to maximize the structural and

542

functional diversity that exists in a space and assuring the availability of different elements with

543

the same function so that the impact of losing some of them during a major disturbance is kept

544

at minimum. In an urban setting, assessing diversity may involve evaluating land use and

545

economic plans, promotion of multifunctionality of the limited landscape to reduce

546 overdependence on hazard-prone activities, creation of goods or services that can be moved or
547 relocated or replaced conveniently, to name a few.

548 Robustness refers to structural or functional, human-made capacities that are introduced to the
549 community to reinforce its sturdiness, such as soft and hard infrastructure. In IRM, this capacity
550 helps the community withstand external threats by preserving its physical capital. In an urban
551 setting, robustness may be reflected by building and planning codes or actual engineered,
552 disaster mitigation structures.

553 Innovation refers to the capacity of the communities to reorganize variables in response to
554 external changes or prepare them into transition to a different state. In IRM, this capacity is
555 boosted by the existence of institutions, the function of which is to introduce creativity in
556 dealing with disasters by transforming them into possible opportunities for new development
557 paths. In an urban setting, this may involve academic institutions or civil society groups that
558 invest in local research for resources sharing and decision-making, promote exchange of
559 information through information and communication technology, employment of renewable
560 sources of energy, leading to promotion of self-reliance by ensuring that the basic local needs of
561 the communities are satisfied.

562 Efficiency refers to the capacity of the communities to quickly but effectively decide on their fate
563 in the face of disturbance. In IRM, this may entail cooperation of stakeholders in multilevel
564 governance from pre-disaster to post-disaster recovery, the ultimate objectives of which are to
565 build assurance of satisfactory level of performance and continuity of the multiple functions and
566 benefits of a landscape despite a disturbance. In urban settings, assessment of the capacity of
567 leaders to guarantee performances in a resource-limited setting, ensure reliability during
568 disaster through emergency and continuity plans, mobilize social networks in post-disaster
569 recovery, and exhibit sense of urgency, trust, leadership, and political decisiveness in the face of
570 disasters (Rijke et al., 2012).



571

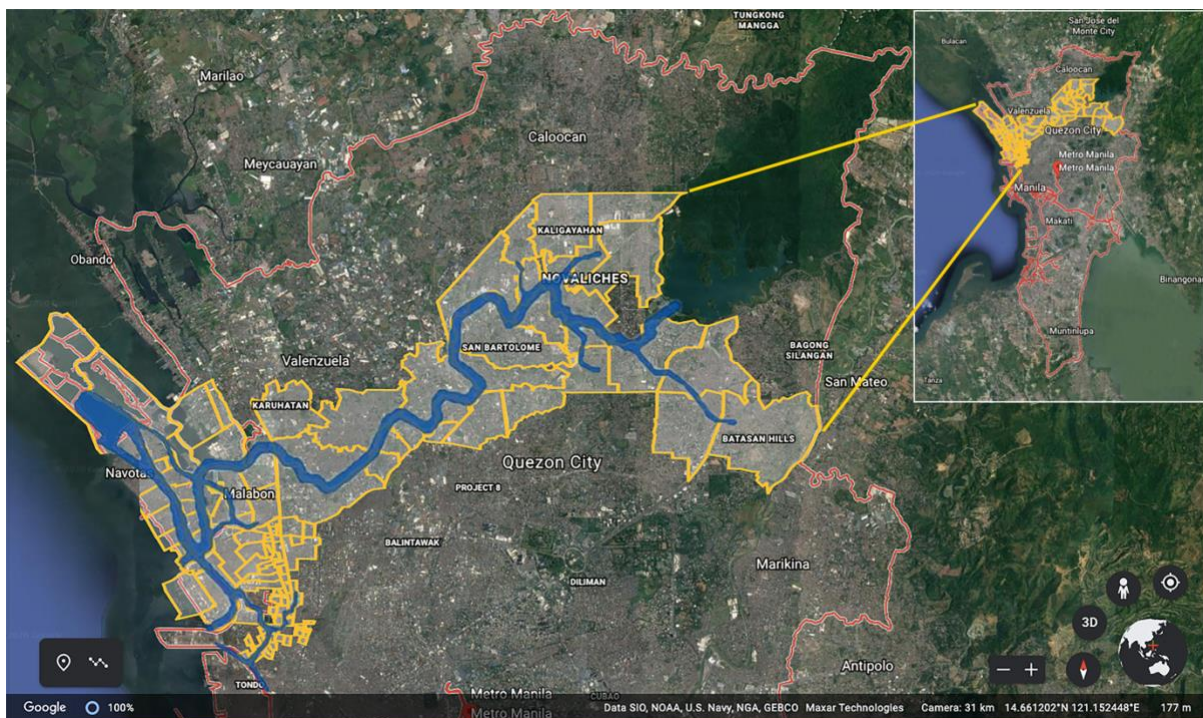
572 *Figure 7. The urban resilience framework with special focus on the most vulnerable group in the system, the urban poor.*

573 In analyzing each of these five aspects, it is important to take note of three elements, how they
574 build capacities, for example, for emergency response, how they prevent or mitigate impending
575 disasters through improvement of social positions, and how they manage recoveries or
576 transitions by assuring an enabling environment. Ultimately, the urban poor resilience
577 framework aims to capitalize on built capacities of the landscape by overcoming sectoral
578 perspectives, in this case defined tailored to the context of an urban landscape.

579 *Location*

580 The area primarily investigated in the risk assessment is the MANATUTI river system as defined
581 by the River Basin Control Office (RBCO). A river basin is an area of land where surface water
582 from rain (or melting snow or ice) converges to a single point, usually the exit of the basin,
583 where the water joins another waterbody (such as ocean). MANATUTI covers the cities of the
584 CAMANAVA sub-region (Caloocan, Malabon, Navotas, and Valenzuela) the northern highland
585 portion of Quezon City, and the northwestern coastal portion of Manila. It drains its headwaters
586 from the La Mesa Dam and Reservoir in Greater Lagro, Quezon City, and runs a 36.4 km (DENR,
587 2019) westward into CAMANAVA mainly through the Malabon-Tullahan river basin on the

588 upstream and its tributaries into the Malabon-Navotas drainage basin downstream, which
589 includes the northwestern coast of Manila. Resorts, manufacturing plants, warehouses, schools,
590 and factories surround the river system. It is one of the three (3) groups of river systems that
591 drain Metro Manila into the Manila Bay, the other two being PAMARISAN (Pasig, Marikina, and
592 San Juan river systems) and the MUNTIPARLASPIZAP (Muntinlupa, Parañaque, Las Piñas-
593 Zapote, and Taguig-Pateros river systems). All three are designated Water Quality Monitoring
594 Areas (WQMAs), which play an important role in issues surrounding water bodies and
595 tributaries (Supreme Court of the Philippines, 2011; DENR, 2019).



596

597 *Figure 8. Location of the MANATUTI river system its surrounding communities in northern Metro Manila (inset). Source:*
598 *Google Earth (2020)*

599

600 MANATUTI spans two of the three landforms that make up the National Capital Region (NCR),
601 the Guadalupe formation in the center and deltaic plain in the west (the other landform outside
602 MANATUTI being the eastern valley from Marikina down to Laguna de Bay) (DENR-NCR, 2015).
603 Quezon City and Valenzuela lie on the high-rise Guadalupe Plateau in the east-central, a

604 moderately high-level landform with solid foundations at the upper east of the region, drained
605 by the San Juan River down south and the Tullahan River up north, and which connects the
606 region to the southeast foot of the Sierra Madre mountain range in Bulacan and Rizal. Caloocan,
607 Malabon, Navotas, and Manila lie on the flat alluvial and deltaic plains in the west, which
608 comprise the coastal margin of the region. Due to this, the entire landscape is influenced
609 primarily by tidal inundations of the Manila Bay in the west and secondarily by water
610 movements in river waterways in Sierra Madre in its northeast. CAMANAVA used to consist of
611 tidal flats of ponds, rice paddies, and urban areas, whereas Quezon City and eastern Valenzuela
612 comprise undulating ridges and lowlands of loam and clay up to the La Mesa Dam and
613 Reservoir.

614 The climate is categorized as Type I according to the Modified Coronas Classification, that is, dry
615 months usually run from November to April while rains are experienced throughout the year.
616 However, erratic changes in the climate patterns have been more obvious and are expected to
617 become more unpredictable in the coming decades. There is a tendency for wetter conditions
618 during the dry season as the frequency of heavy storms during this period has increased. The
619 mean annual temperature in the region is 30.8°C and the annual mean rainfall, 152.42 mm. With
620 a population of 2.3 million mostly living under poverty threshold, hazards that the landscape is
621 exposed to may pose risks to a significant number of vulnerable citizens and their properties.

622 *Data Collection*

623 Key informant interviews were conducted with concerned national government agency (NGA)
624 representatives. Focus group discussions were conducted among concerned offices of each city
625 local government unit (LGU) as well as community members representing vulnerable sectors.
626 Partners were asked to share their opinions and expertise on the most pressing threats to the
627 character of the landscape, which formulated the basis on which the conceptual framework and
628 consequently, risk assessment model, were simultaneously developed. Questions posed were

629 why, where, and how disasters occur, geophysical and meteorological assessment in
630 combination with the socioeconomic setting of the landscape.

631 Hazard is defined as a potential threat that is likely to damage the landscape character when it
632 occurs (Trovato et al. 2017) or an object or activity and its disruptive influence on the landscape
633 of concern (Hunsaker et al. 1990). The endpoint or the environmental concern is defined to be
634 damage to quality of life and property, the sources are either natural or man-caused, and the
635 reference environment is the entire river basin. Regional risk assessments like landscape-wide
636 risk assessments differ in the extent of interaction of hazards in the constituent communities
637 across the landscape and the degree to which boundary definition and spatial heterogeneity are
638 significant. They are chosen according to the following criterion: Severity in terms of the effect
639 of the occurrence at a location (e.g., constituent city), applicability across the cities, availability
640 of information, and relevance to the results from available community risk assessments.

641 *Data Analysis*

642 Hazard assessment is done by processing information taken from different kinds of maps
643 and/or field work. It is a multi-stakeholder process, involving actors with diverging interests,
644 impacts, and positions of power and therefore motivations. The stakeholder analysis provides
645 more detailed information, attitudes, interests, perceptions, and power relations. Capacities and
646 vulnerabilities are assessed in such a way that the land use of one actor may drive risk for the
647 livelihood of another. It is important to analyse the socio-political and economic factors that
648 influence actors and disaster risk. Hazard and Vulnerability Index Method was used to assess
649 the impact of accidents on the environment and prioritize the risks on the cities up to the size of
650 the river system (Vojkowska & Danihelka 2002).

651 Risks were then assessed by classifying them into three categories: A, with low and therefore
652 acceptable risk, especially when standard safety measures are followed, B, with increased

653 potential risk, thus, it is necessary to reduce such a risk and carrying out the planned spatial
654 development in the given area is not recommended and looking for another area, modifying the
655 spatial development plan, and/or re-assessing the proposed spatial development plan are
656 suggested, and C, with high potential, extensive, and serious risk of damage to the environment,
657 thus, it is unacceptable and less vulnerable area or rechecking the range and level of hazard of
658 the spatial development is recommended (Rehak et al. 2011).

659 **Findings**

660 *Hazards*

661 Hazard is defined as any event, process, or activity that may incur loss in human life or
662 livelihood, damage to health, property, or the environment, or disruption in socio-economic life
663 (United Nations Office for Disaster Risk Reduction [UNDRR], 2020). It may be natural,
664 predominantly caused by natural processes or phenomena, anthropogenic, predominantly
665 caused by human activities and decisions, or socio-natural, any combination of natural,
666 anthropogenic, or other complex factors, including environmental degradation and climate
667 change. They may be single, successive, or simultaneous both in source and impact.

668 Following the Sendai Framework for Disaster Risk Reduction 2015–2030 classification scheme,
669 hazards are grouped in this text into (1) hydrometeorological, which are atmospheric,
670 hydrologic, or oceanographic in origin, (2) geological, which originate from the earth's internal
671 activities, (3) technological, which originate from residential or industrial processes, (4)
672 environmental, those created by environmental degradation, and which may be a driver of
673 another hazard or risk rather than hazard on its own, and (5) biological, which originate from
674 living organisms and their byproducts.

675 The leading hazards around the MANATUTI river system, in decreasing order of frequency for
676 each category, include: for hydrometeorological, (1) flooding, (2) tropical cyclone, (3) storm
677 surge, as a consequence of a tropical cyclone, (4) heat wave, as exacerbated by temperature
678 increase, and (5) rainfall increase and (6) sea-level rise, which cause further flooding or storm
679 surge; for geological, (7) ground subsidence, (8) earthquake, (9) liquefaction (as a result of
680 earthquake), and (10) tsunami; for technological, (11) fire, (12) substandard buildings, and (13)
681 shipping vessels; for environmental, (14) land, water, and air pollution and (15) red tide; and
682 for biological, (16) urban pests and (17) viral outbreaks.

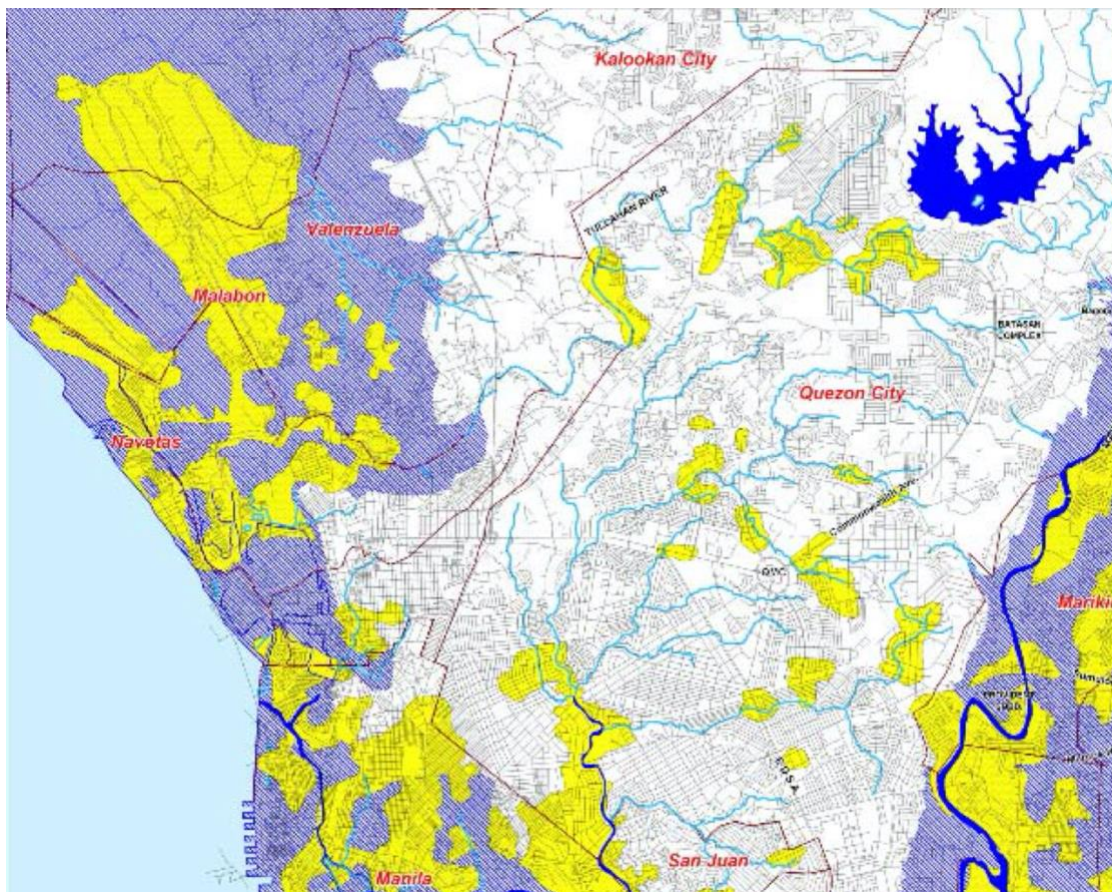
683 **Hydrometeorological.** Hydrometeorological hazards are disruptive systems or processes that
684 occur in the atmosphere and hydrosphere, especially in the oceans. The earth's water cycle is
685 responsible for the regular distribution of water that is vital to living organisms, especially
686 humans. However, due to accelerated climate change, some parts of the water cycle also
687 undergo extreme changes that pose threat to lives and properties, such as increased
688 precipitation that worsens flooding, among others. (UNDRR, 2020). The Philippines is located in
689 a typhoon belt, and so monsoon rains and typhoons have regularly submerged parts of the
690 country, especially the capital region (Ragodon, 2019). Flooding took longer to subside in 2018
691 (30 minutes) than the previous year (18.5) (Business Mirror, 2019). Of the 170 programmed
692 flood-control projects for 2018, only 53 or a third were completed (COA, 2019). Indeed, the
693 Great Flood of 1972 was caused by four successive typhoons, Edeng, Gloring, Isang, and
694 Huaning (Ragodon, 2019).

695 1. Flooding

696 CAMANAVA lies on a low-lying flat terrain located in the estuary of river deltas, with the ground
697 elevation in major parts being below high tide level. This makes the sub-region susceptible to
698 flooding, especially during high tide. Flooding is most frequent during rainy seasons from May
699 to September, when high tides take place simultaneous with heavy rains (Community Disaster
700 Preparedness and Management; Climate and Development Knowledge Network, 2015). In
701 Valenzuela, the relatively more highland portion of the sub-region, about 25% of the city is
702 below sea level, which still makes drainage very difficult (Cities Development Initiative for Asia,
703 2018). Flooding in the Quezon City segment of MANATUTI, if any, may be caused by movement
704 of the headwaters in the La Mesa Watershed, like overflowing of the dam itself or the heavily
705 silted tributaries down the river system, or clogged drainages in the suburbs.

706 The flood control project in CAMANAVA that started in 1997 remains unfinished. With the
707 feasibility plan review that followed in 1998, the project must have been completed by 2007,

708 but was extended to 2009. Only 18 components were completed as of 2008: Pumping stations,
 709 floodgates, the Navotas Navigation Gate, the Bangkulasi Drainage Main (Navotas), and the
 710 Maralla River Channel Improvement. The remaining works since 2009 included the polder dikes
 711 along the Pinagkabalian river and Kailugan river, and the Malabon River Channel improvement
 712 with over 3 km of right and left banks. However, the Habagat (southwest monsoon) rains of
 713 2012 overtopped the polder dikes, which necessitated another raising by a meter. Ripraps, the
 714 upgrade of the elevation of the polder dike, Catmon creek and riverwall rehabilitation, and
 715 construction of pumping station and floodgates still remain unfinished as of 2013, which were
 716 carried over to the succeeding Flood Management Master Plan for Metro Manila and
 717 Surrounding Areas worth P351B (Romero, 2013).

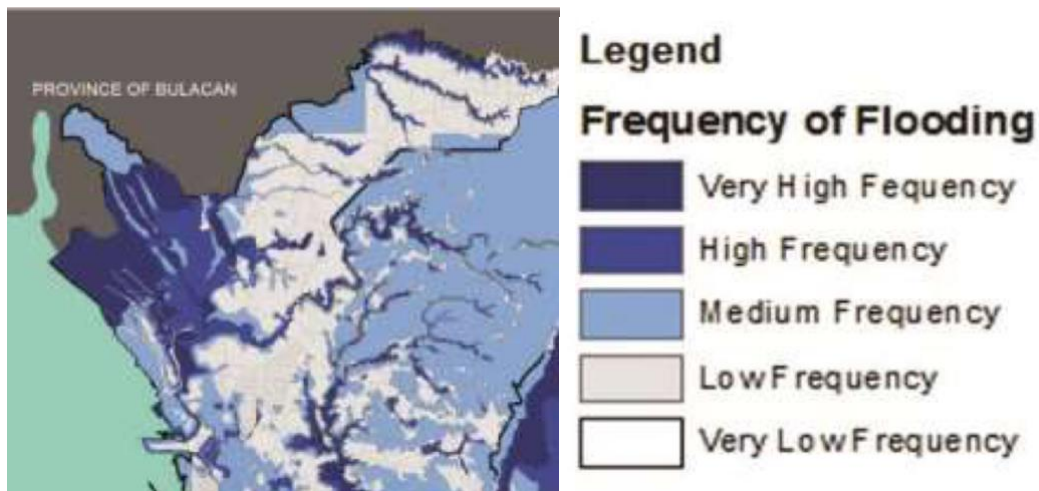


718
 719 *Figure 9. Flood risk map of northern Metro Manila, showing most flood-prone areas for 2 to 10-year flood cycle (yellow)*
 720 *and 50 to 100-year flood cycle (purple). Notice the very flood-prone western half of MANATUTI covering Navotas, Malabon,*

721 *Manila, and the western portion of Valenzuela. The outline of the MANATUTI river system (labelled Tullahan River) can also*
722 *be seen. Source: DENR Mines and Geosciences Bureau Lands Geological Survey (2009)*

723 In the 2014 performance audit of the CAMANAVA Flood Control Project, flood mitigation failed
724 because of deficiencies in structures, existence of informal settlers and large volume of garbage,
725 and inadequate personnel and communication facilities. The volume of garbage was found to
726 obstruct the flow of water especially at the trash rake section and therefore the maximum
727 suctioning capacity of the pump was not attained. A MOA entered into by DPWH and the
728 Caloocan, Malabon, and Navotas LGUs were not duly carried out, including implementation of
729 waste management system, clearance from informal settlers, enhancement of environment and
730 ecological protection program through Zero Waste Management to ensure that esteros remain
731 garbage free, and mobilization of advocacy efforts to educate the people about the need for
732 unrelenting support to maintain cleanliness as a measure of flood control (COA, 2014).

733 By 2020 and 2030, 50-57% of the barangays in Manila, Malabon, and Navotas and 28% in
734 Valenzuela will be at high risk to flooding (Pornasodoro et al. 2014). By 2030, the following
735 barangays will be at high flood risk in Manila: 556 barangays in the districts of Tondo, Sta. Cruz,
736 Malate, Sampaloc, Paco, Quiapo, Binondo, Pandacan, Intramuros, Ermita, Port Area near Pasig
737 River and tributaries; in Caloocan: 27 barangays in North Caloocan and 36 in South Caloocan; in
738 Malabon: Barangay Dampalit, Catmon, Muzon, Concepcion, San Agustin, Nugan, Ilongos, and
739 Potrero; in Navotas: Barangay Tangos, Daang-hari, San Jose, North Bay Blvd., Navotas East and
740 West, Bangculasi; in Valenzuela City: Barangay Marulas, Malinta, General T. de Leon, Caruhatan,
741 Mapulang Lupa, Dalandanan, Isla, and Pariancillo Villa; in Quezon City: Barangay San Bartolome,
742 Nagkakaisang Nayon, Sta. Lucia, Bagong Pagasa, Tatalon, Doña Imelda, Matandang Balara,
743 Culiati, Apolonio Samson, Ramon Magsaysay, Alicia, Baling-asa, and Paltok.



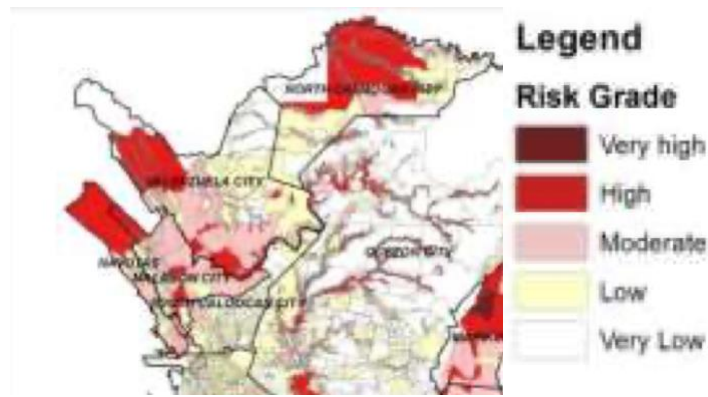
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745 *Figure 10. Flood vulnerability map of northern Metro Manila. Notice the consistently flood-prone western CAMANAVA. The*

746 *outline of the MANATUTI river system is conspicuous at a very high frequency flood vulnerability. Source: Pornasodoro et al.*

747 *(2014)*

748 By 2030, the following barangays will be at very high risk of flooding: in Manila, 243 barangays
749 in Tondo, Sta. Cruz, Sampaloc, Paco, Quiapo, Binondo, Pandacan, Intramuros, Ermita, Porta Area
750 near the Pasig River and tributaries; in Caloocan: Brgys. 8, 12, 14, 35-36, 168, 171, 173-178,
751 180-183, and 185-187; in Malabon: Barangay Tonsuya; in Navotas: Barangay Tanza; in Quezon
752 City: Commonwealth, Payatas, Holy Spirit, and Batasan; in Valenzuela: Wawang Pulo, Tagalag,
753 Coloong, Balangkas, Bisig, Malanday (Pornasodoro et al., 2014). Flooding typically brings other
754 hazards like health, which include diseases like leptospirosis, dengue, and bronchopneumonia
755 (Community Disaster Preparedness and Management, 2019).

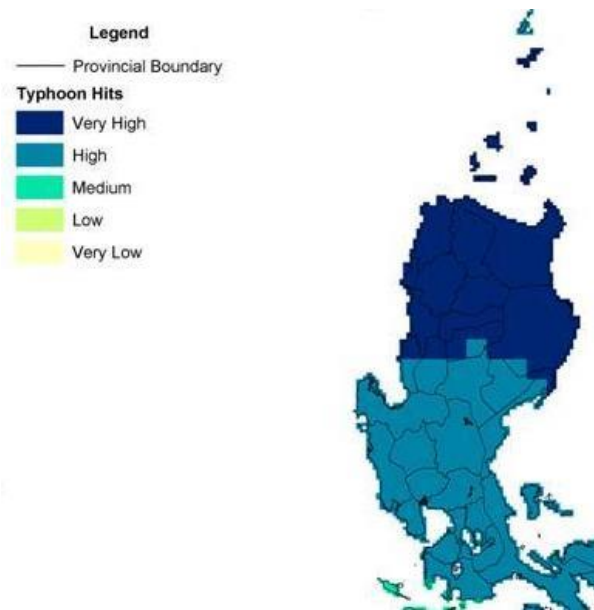


756

757 *Figure 11. Disaster risk map of northern Metro Manila due to flood, taking into account demographic and household*
758 *characteristics of communities. Notice the consistently flood-prone western CAMANAVA. The outline of the MANATUTI river*
759 *system is conspicuous at a high risk grade. Source: Pornasoro et al. (2014)*

760 2. Tropical cyclone

761 A tropical cyclone is a strong, whirling wind that often brings strong and lasting rainfall. It is
762 formed in oceans where hot and humid and cool and dry air meet and form magnified
763 turbulence in the atmosphere. Most tropical cyclones are formed in the Pacific Ocean, around 20
764 of which enter the Philippine Area of Responsibility (PAR) every year.



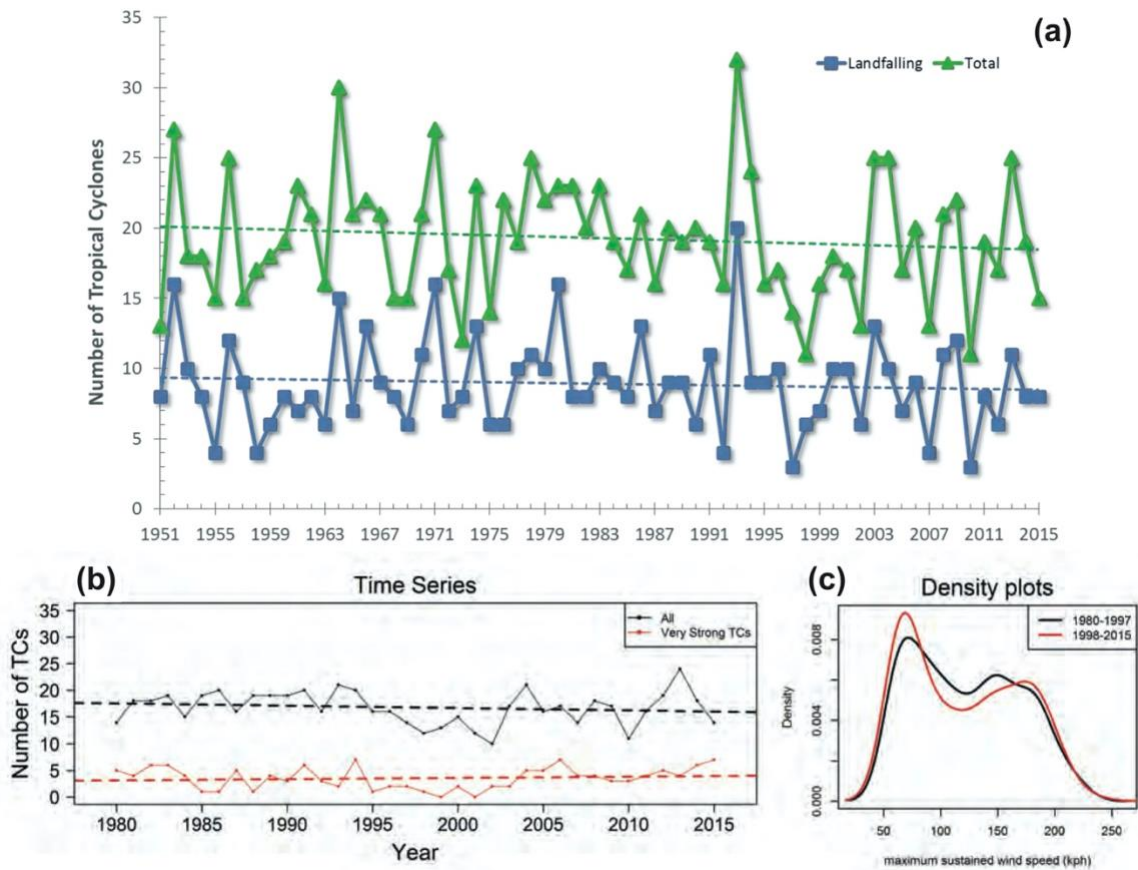
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766 *Figure 12. Typhoon frequency across the greater part of Luzon, showing relatively high typhoon incidence for Metro Manila.*

767 *Source: DENR & Manila Observatory (2018)*

768 Two of the strongest typhoons that hit Metro Manila in the region's history were Joan 1970 and
769 Angela 1995 (Flores, 2017; Typhoon2000.ph). Locally named Sening and running at 275 kph,
770 supertyphoon Joan twisted large neon road signs and billboards in Metro Manila and left
771 hazardous debris in the streets, eventually killing a total of 768 people and damaging PHP 1.89B
772 worth of properties in the entire country. Locally named Rosing and running at a relatively
773 weaker 260 kph, supertyphoon Angela destroyed glass panels of buildings and twisted metal
774 trusses, flagpoles, and neon billboards in Metro Manila, eventually killing a total of 936 people,
775 damaging 96,000 homes, roads, and bridges, and PHP 10.829B worth of properties in the entire
776 country, way worse than Joan's aftermath. It is also worth noting that the track of the two
777 strongest typhoons to landfall in the country in history, supertyphoon Haiyan (Yolanda) in 2013
778 and just recently, supertyphoon Goni (Rolly) in 2020, were also initially predicted to pass
779 through Metro Manila, showing that typhoons stronger than 220 kph are still possible to ravage
780 the region.

781 Tropical cyclones do not only pose threats to life and properties due to their strong winds, they
 782 also more often bring massive rainfall regardless of wind strength. For Metro Manila in
 783 particular, this has been the case in the worst flooding incident in history after the Great Flood
 784 of 1972, which was caused by a tropical storm-level cyclone in 2009, Ketsana, locally called
 785 Ondoy (Rabonza, 2009). Scores of people were dead and hundreds displaced as 80% of the city
 786 of Manila alone was submerged. Even though the PAMARISAN river system was the most
 787 affected back then, cities along the MANATUTI track, especially Manila, Caloocan, and Quezon
 788 City, were also submerged from knee to neck to rooftop levels of flood waters.



789

790 *Figure 13. Trends in the frequency and intensity of tropical cyclones that enter PAR since the 1950s: (a) annual number of*
 791 *tropical cyclones, (b) downward trend in the total number but upward trend in the number of very strong tropical cyclones,*
 792 *(c) increase in the number of strong tropical cyclones in the past almost two decades. Source: PAGASA (2018)*

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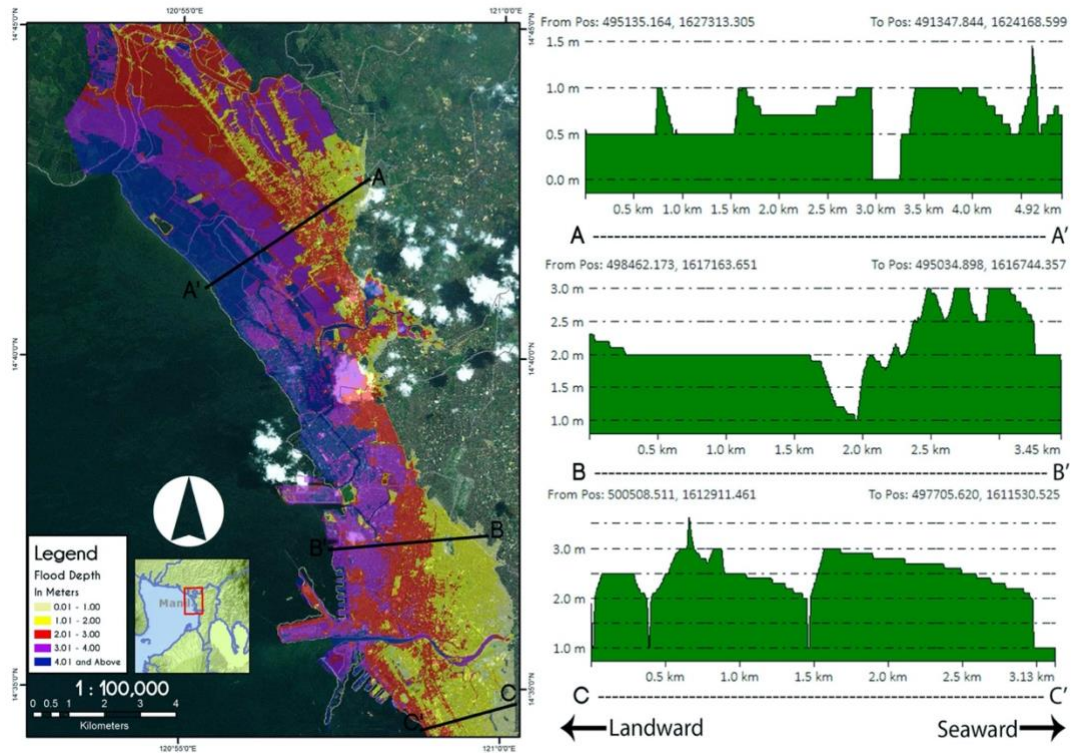
794 3. Storm surge

795 A storm surge is the abnormal rising of the sea level due to the push of strong winds on the
796 water surface, the accumulation of big waves, pressure, and astronomical tide moving towards
797 the shore (PAGASA, 2019). Typhoons characterized by strong winds may cause high storm
798 surges (NOAA, 2019). Storm surges become more dangerous when it arrives on top a high tide;
799 this may cause flooding in seldom flooded areas (PAGASA, 2019). PAGASA classifies impact of
800 storm surges based on their height: Yellow alert, possible storm surge of 1-2 meters above sea
801 level (masl); Orange alert: storm surge of 2.1-3 masl is expected, with possible flooding in low-
802 lying areas and severe damage to coastal communities; and Red alert: storm surge is
803 catastrophic if more than 3 masl, aggravates river flooding and life-threatening.

804 Metro Manila is not spared from storm surges. In 2011, Typhoon Pedring caused a storm surge
805 that destroyed the sea walls of Manila Bay and submerged the US Embassy and Sofitel
806 Philippine Plaza in flood. The coastal margin of Metro Manila, which covers Caloocan, Malabon,
807 Navotas, and Manila, is specifically prone to 2.01-4.00 masl storm surge height, with a maximum
808 surge height of 3.90 m, although a study by Suarez et al. (2016) estimated a storm surge height
809 of 3.9 to 5.6 m in the western seaboard even after considering the diminishing effect of surface
810 friction if a Haiyan-like typhoon is to traverse tracks like those of Rita 1978, Collen 1992, Sybil
811 1995, Bebinca 2000, and Xangsane 2000. The most devastating storm surges in the Philippines
812 so far happened in the last four months of any given year.

813 Even though it is only 22nd in the list of provinces prone to highest storm surges in the entire
814 country, Metro Manila has the highest low-elevation coastal zone population density of > 1000,
815 together with Leyte (Lapidez et al., 2014), and therefore bigger population is exposed if a storm
816 surge occurs. Lapidez et al. (2014) further explained that large rivers and urbanization have
817 created gentle slopes across the landscape in the coastal margin of Metro Manila, allowing flood
818 water to propagate farther inland during a storm surge. Among the cities covered by
819 MANATUTI, Navotas, Malabon, and Manila are the most coastal and therefore, more prone to

820 high inundations caused by storm surges, followed by Caloocan and Valenzuela (Tablazon et al.
 821 2015).



822

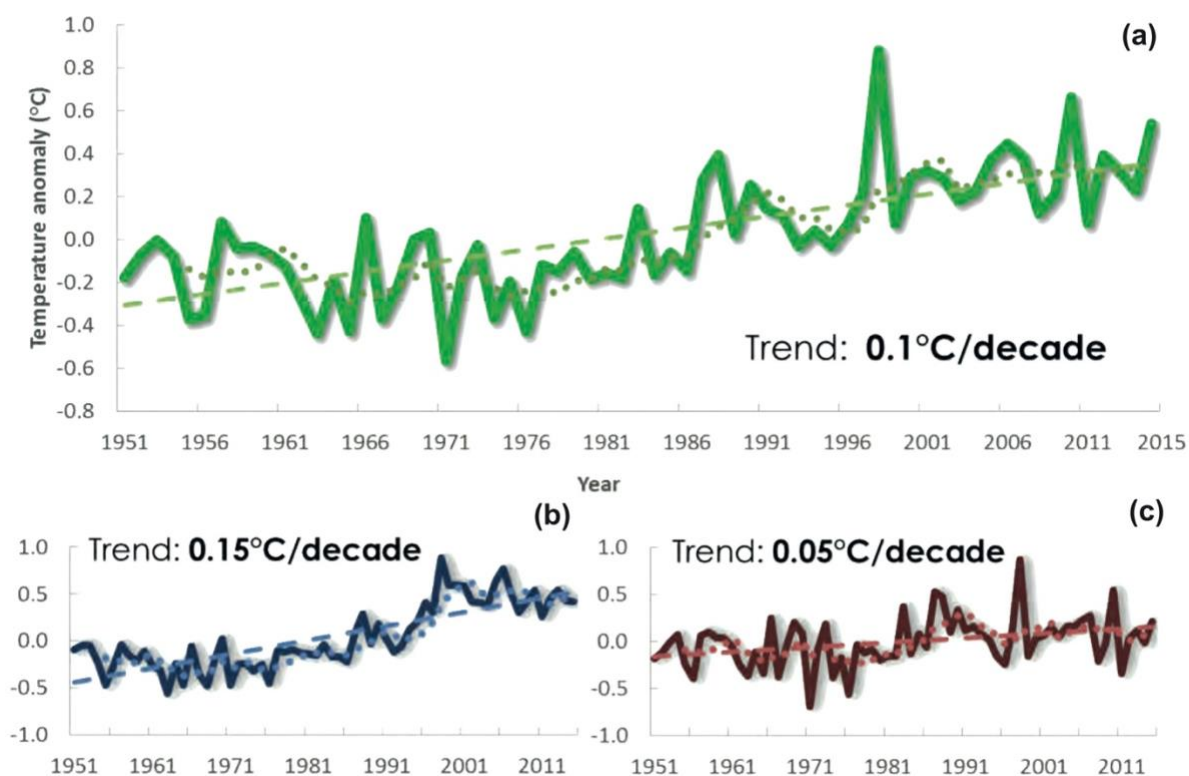
823 *Figure 14. Inundation map of northwestern Metro Manila showing the Navotas and Manila coasts and inland western*
 824 *Malabon to be submerged in 1-4 m flood following a worst case storm surge-inducing typhoon in the West Philippine Sea.*

825 *Source: Lapidez et al. (2015).*

826 4. Heat wave

827 Extreme temperature increases have also become frequent in Metro Manila in the recent years,
 828 also known as heat waves. Heat waves occur when ambient temperatures consistently reach

829 32.22 degrees Celsius for 3 or more days. This brings extremely hot and humid air for extended
 830 periods, which may pose adverse effects on health.



831

832 *Figure 15. Temperature change trend in the Philippines per decade from 1951-2015: (a) change in mean annual*
 833 *temperature, (b) change in minimum temperature, (c) change in maximum temperature. Source: PAGASA (2018)*

834 Summer temperature changes in Metro Manila have drastically changed throughout the years.
 835 Warmer temperatures also tend to reduce air quality. Energy production and consumption is
 836 also affected by extreme heat, e.g., higher electricity demand.

837 *Table 1. Projected seasonal temperature increase in Metro Manila in the next 15-45 years given a mid-range emission*
 838 *scenario. All values in °C. Source: PAGASA (2011)*

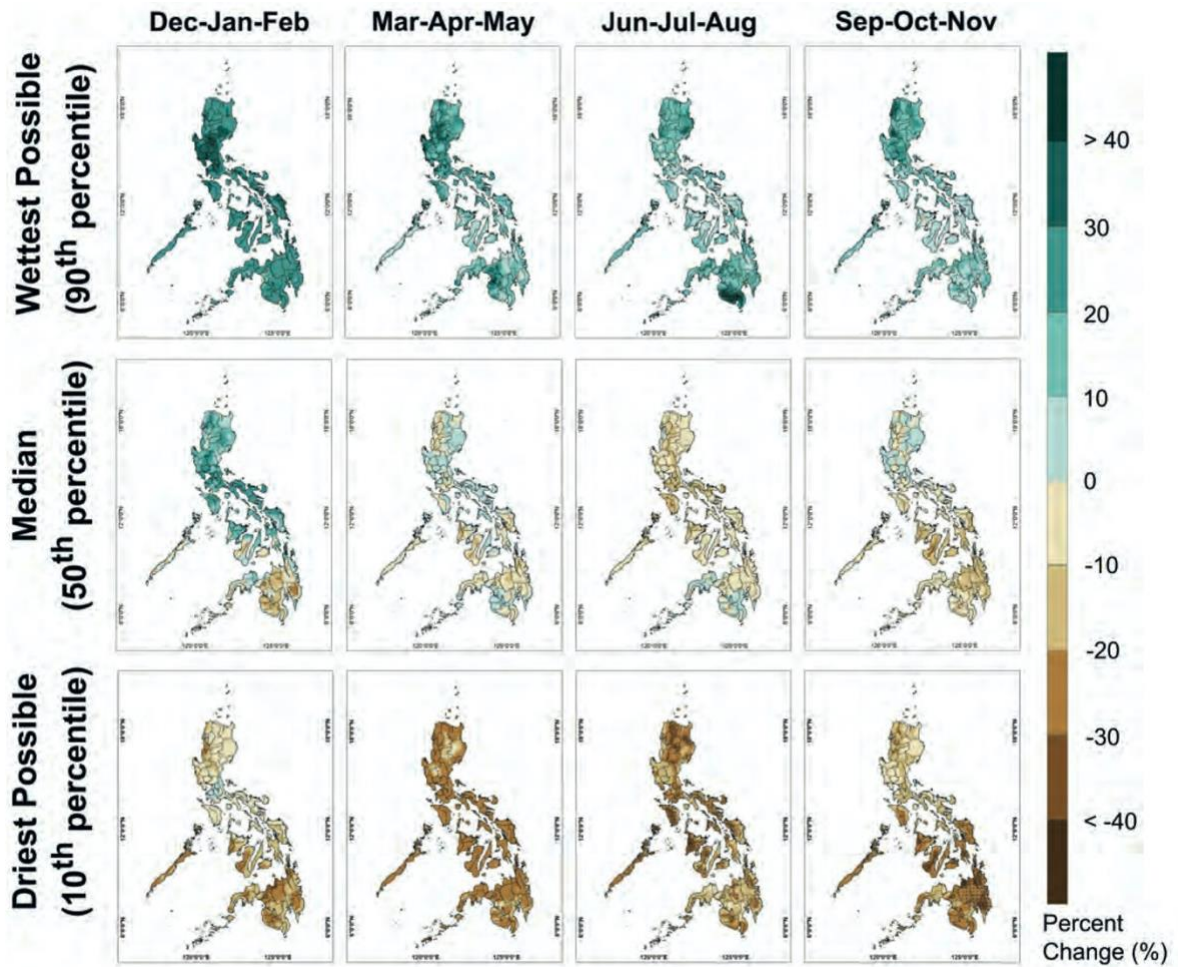
Quarter (month initials)	Observed baseline (1971-2000)	Change in 2020 (2006-2035)	Change in 2050 (2036-2065)
DJF	26.1	1.0	2.0

MAM	28.8	1.1	2.1
JJA	28.0	0.9	1.8
SON	27.4	1.0	1.9

839

840 5. Sea-level rise and rainfall increase

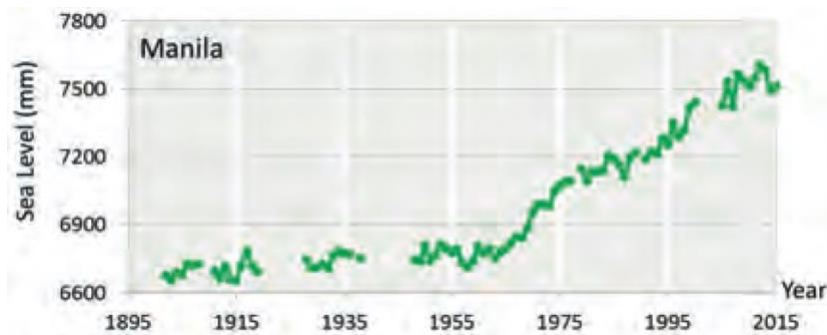
841 The sea level rise along Manila Bay is about 15 cm per decade. Sea level rise may affect nearby
842 freshwater aquifers that may result in flooding as well as the storm surge vulnerabilities of
843 coastal communities. Rainfall variability for the past few years is also making it more difficult to
844 predict precipitation events on an inter-seasonal basis.



845

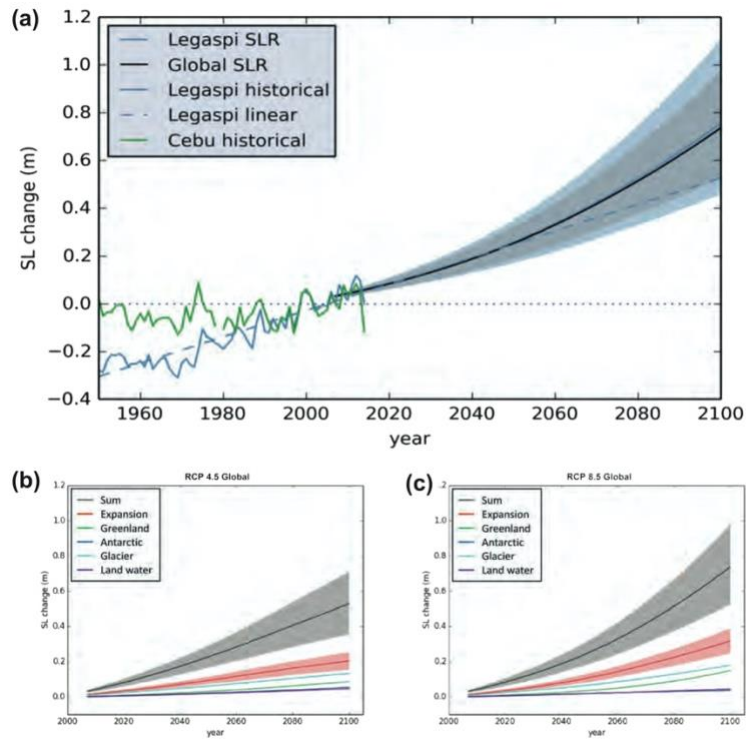
846 *Figure 16. Rainfall change projection in the Philippines in the next 16-45 years from highest increase (wettest) to highest*
 847 *decrease (driest). Notice the consistent relative increase in precipitation in Metro Manila and CALABARZON. Source:*
 848 *PAGASA (2018)*

849



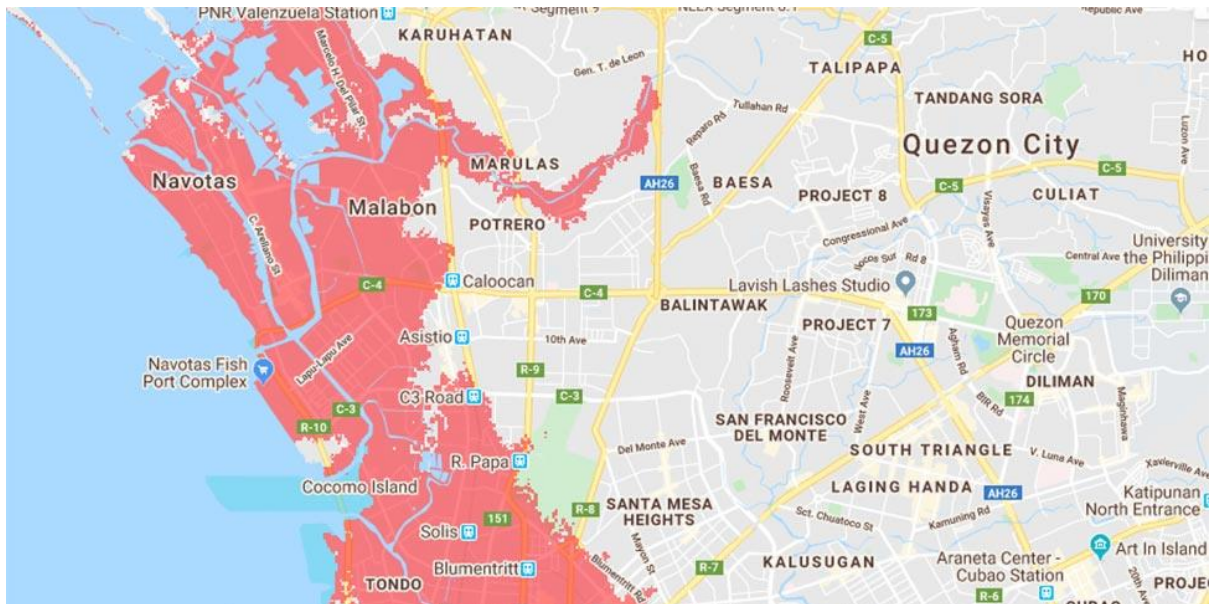
850

851 *Figure 17. Sea level increase in Metro Manila through the years. Source: PAGASA (2018)*



852

853 *Figure 18. Sea level change projection until 2100: (a) following measurements from tide gauges in Bicol and Cebu since*
 854 *1960 given a high-emission scenario, (b) global projection under a mid-emission scenario, (c) global projection under a high-*
 855 *emission scenario. Source: PAGASA (2018)*



856

857 *Figure 19. Sinking of the western portion of MANATUTI is predicted by 2050 due to sea level rise brought by accelerated*
 858 *global warming. Source: Climate Central (2019)*

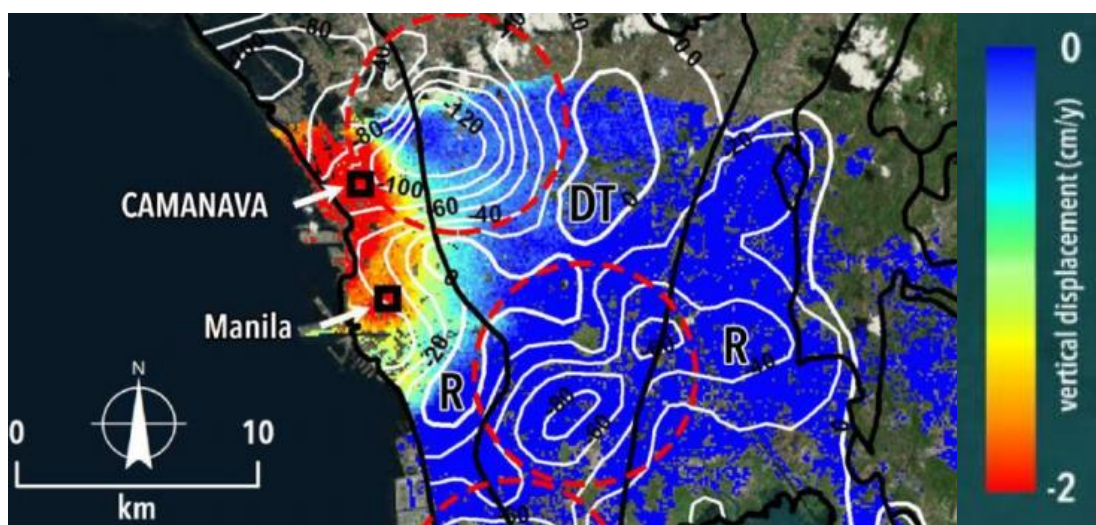
859

860 **Geological**

861 6. Ground subsidence

862 An additional hazard rarely mentioned in many risk assessments, both technical and
 863 community-based, is ground subsidence, which may possibly be aggravated by other natural
 864 hazards, including auto-compaction, sea level rise due to accelerated climate change, and man-
 865 made hazards such as over-extraction of ground water, especially since the 1980s. Global
 866 warming that causes the sea level to rise about a little more than an inch over a decade, coupled
 867 with continued ground subsidence, may aggravate flooding in the river system. Storm surges
 868 are mostly due to climate change but also due to subsidence.

869 Land subsidence, in turn, may be aggravated by overutilization of groundwater due to loss of
 870 support below ground. In Metro Manila, groundwater extraction sinks the soil around 6 inches
 871 every year. Ground subsidence is evident in Las Piñas and CAMANAVA but faster in the former.
 872 Groundwater extraction from industries, agriculture, and aquaculture has the most impact in
 873 Metro Manila. While groundwater levels may revert to past levels, subsidence is permanent (De
 874 Vera-Ruiz, 2018). In fact, despite lessened groundwater extraction due to regulation,
 875 CAMANAVA remains sinking for about 1-2 inches annually.



876

877 *Figure 20. Ground subsidence rate in northern Metro Manila. Notice the disparate velocity of subsidence in the western*
 878 *MANATUTI relative to other parts of the region. Source: Eco & Rodolfo (2018)*

879 7. Earthquake

880 Earthquakes are weak to strong movement of the ground due to fissures of movement of rocks
881 below the earth's surface. Located along the Pacific Ring of Fire, faults abound underneath the
882 country's islands and oceans and so earthquakes are felt throughout the country every so often.
883 Despite the presence of the Marikina Valley Fault System, the last destructive earthquake that
884 occurred in Metro Manila was as far back as in the Spanish colonial era in 1880, when intensity
885 X shaking in then Rossi-Forel scale destroyed the Manila Cathedral belfry. Forward to the new
886 millennium, the first comprehensive earthquake risk analysis for the region entitled Metro
887 Manila Earthquake Impact Reduction Study (MMEIRS) classified the subregion traversed by
888 MANATUTI with high flammability and evacuation difficulty (JICA, 2004). This was supported
889 by the integrated risk analysis of Greater Metro Manila Area (GMMA-RAP) and the Metro Manila
890 Earthquake Contingency Plan (Oplan Metro Yakal Plus), which were specifically based on the
891 worst case 7.2 magnitude movement of the West Valley Fault and intensity VIII ground shaking
892 (Bautista et al., 2014; NRRMC, 2015). The assessments divided the MANATUTI area into two
893 quadrants that will be isolated based on building and bridge collapse, the west quadrant
894 consisting of Manila, Navotas, and Malabon, and the north quadrant consisting of Caloocan,
895 Valenzuela, and Quezon City (NDRRMC, 2015).

896 The effects of the earthquake may be felt despite distance from the West Valley Fault, even in
897 Caloocan (Melican, 2013). Manila, South Caloocan, and southern Malabon will feel the same
898 intensity levels as those in the fault line because its foundation is thick sediments that amplify
899 ground shaking (Melican, 2013), while Navotas, Valenzuela, and Quezon City will feel less. The
900 April 2019 Zambales quake resulted in damages in Metro Manila beyond expected for such
901 magnitude and distance. The Big One is anticipated to cause floor damage from 64 to 88 square
902 kilometers, PHP 1.8 to 2.3M worth of economic losses, and death toll from 23 to 31 thousand in
903 the Greater Metro Manila Area (PHIVOLCS, 2014).

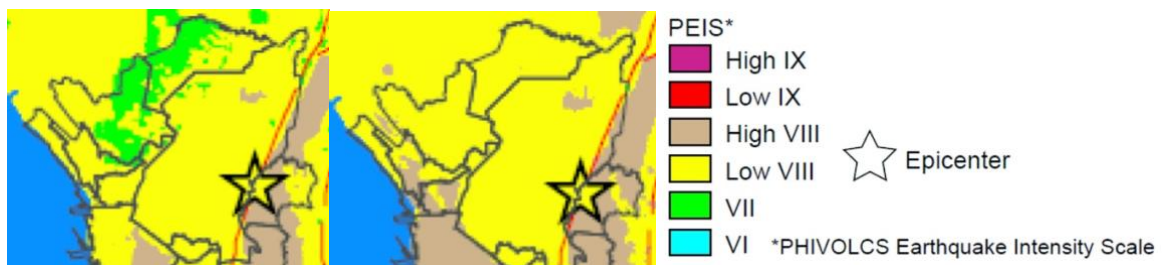
904 Last January the Taal Volcano recorded several volcanic earthquakes, some of which were felt in
 905 Metro Manila albeit subtly.

906



907 *Figure 21. Location of Metro Manila in relation to the two most significant geologic structures that cause seismic*
 908 *movements in the region, the Manila Trench (purple) and the Valley Fault System (red). Source: PHIVOLCS (2000)*

909



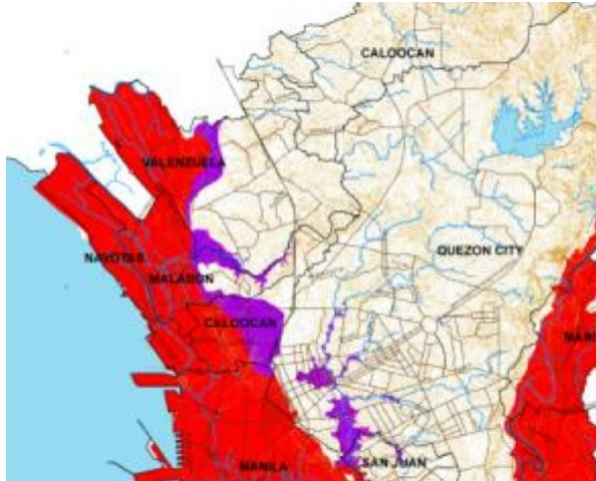
910

911 *Figure 22. Ground shaking hazard map for northern Metro Manila in the event of a M6.5 (left) or M7.2 (right) West Valley*
 912 *Fault earthquake. Intensity 7 to high 8 will be felt along MANATUTI, with greater intensity along the coast. Source:*
 913 *PHIVOLCS (2014)*

914 8. Liquefaction

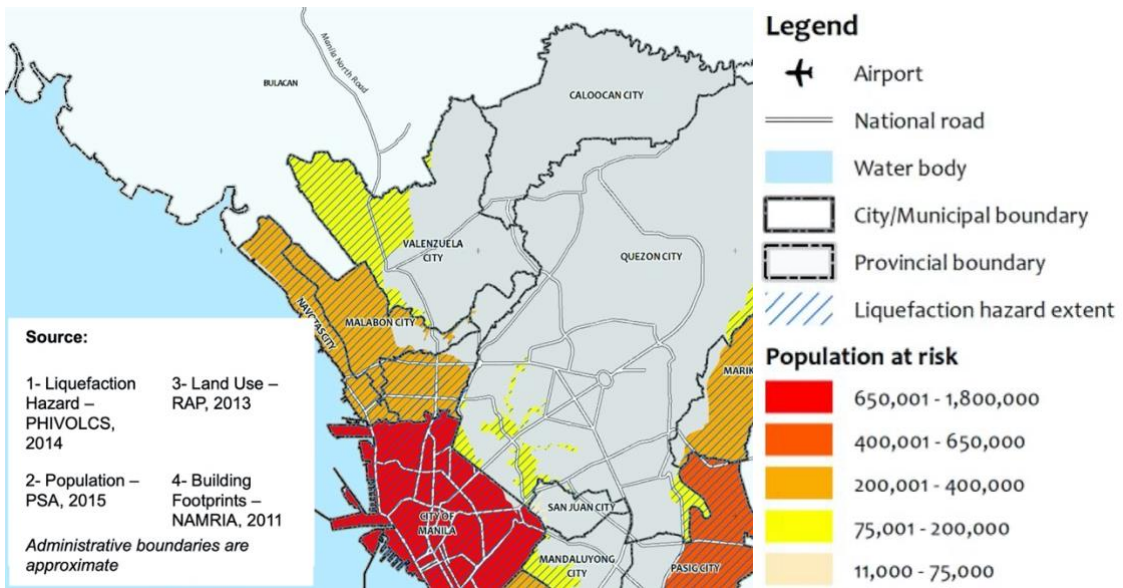
915 Liquefaction occurs in loose, saturated sandy ground and is the loss of strength of that ground
 916 due to strong ground motion. Liquefaction damaged Dagupan in a 1990 earthquake. Among the
 917 cities covered by MANATUTI, Caloocan, Malabon, Navotas, and Manila are the most prone to
 918 liquefaction, followed by Valenzuela.

919



920 *Figure 23. Liquefaction susceptibility map of northern Metro Manila. Notice the high (red) and moderate (purple)*
 921 *susceptibility of coastal MANATUTI. Source: PHIVOLCS (2014)*

922



923

924 *Figure 24. Population in western MANATUTI at risk to liquefaction following the Big One. Source: PHIVOLCS (2014)*

925

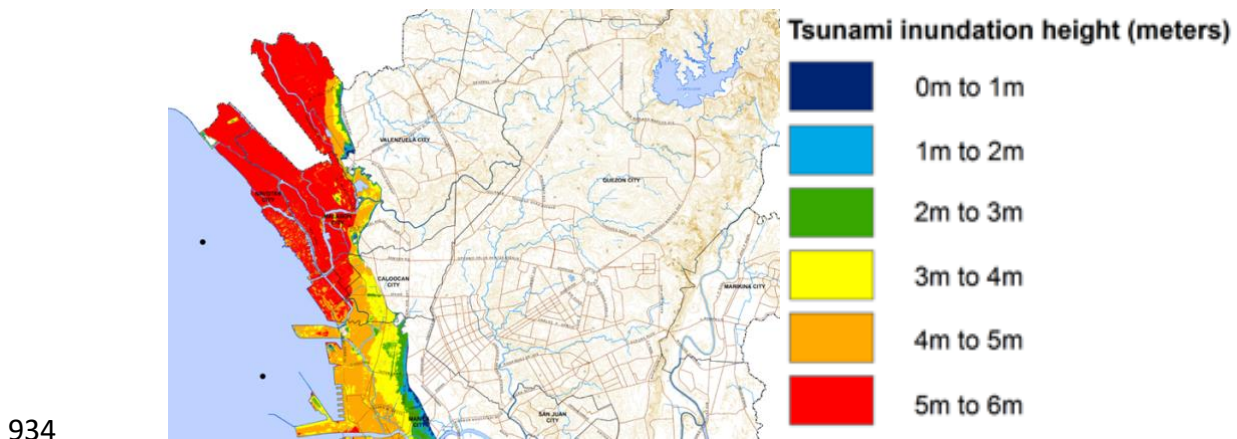
926 9. Tsunami

927 Finally, a tsunami is a series of waves generated by undersea earthquakes that are shallow and

928 strong enough to displace parts of the seabed and disturb the mass of water over it. Tsunami

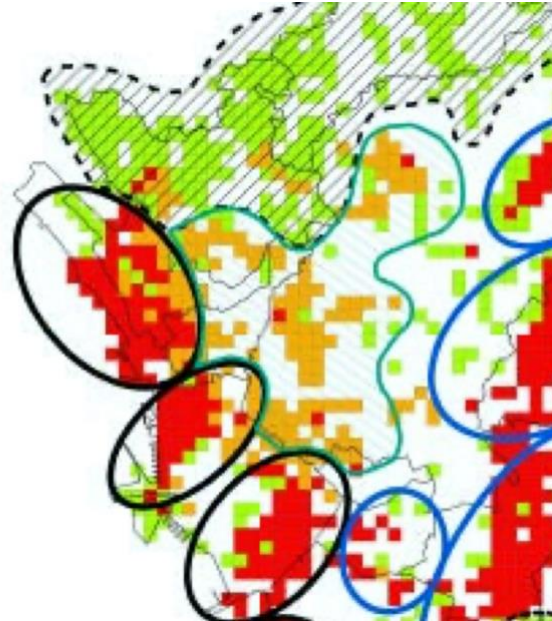
929 waves can reach as high as beyond 5 m and move as fast as 800 kph. The anticipated Big One is
930 not capable of generating a tsunami unless the Manila Trench moves (Gita, 2015). Manila and
931 CAMANAVA will be affected.

932 The anticipated Big One is not capable of generating a tsunami unless the Manila Trench moves
933 (Gita, 2015). Manila and CAMANAVA will be affected.



935 *Figure 25. Tsunami wave height map of northern Metro Manila following the Big One. Across coastal MANATUTI, notice the*
936 *higher inundation in Navotas and Malabon relative to Caloocan and Manila. Source: PHIVOLCS (2013)*

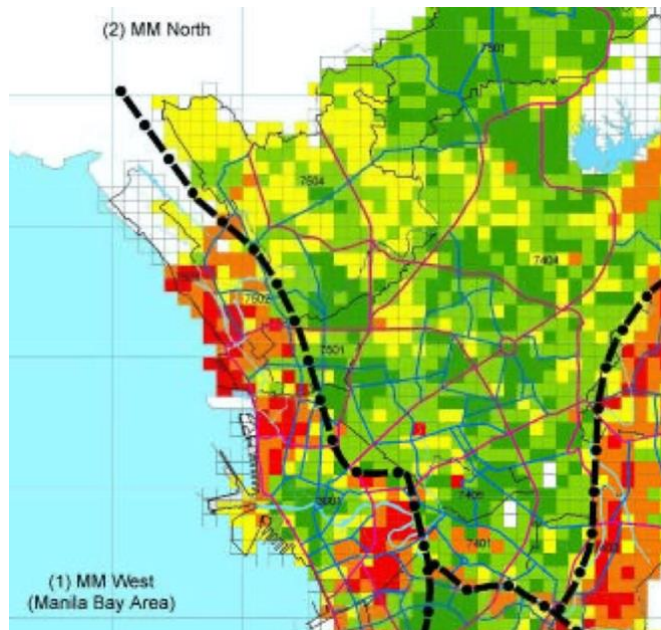
937



938

939 *Figure 26. Vulnerability characteristics of northern Metro Manila to other earthquake-induced hazards. Notice the high*
940 *comprehensive vulnerability of western MANATUTI (red). Green – high evacuation difficulty, orange – high flammability.*
941 *Source: MMEIRS (2004)*

942



943

944 *Figure 27. Regional separation of western and eastern MANATUTI according to comprehensive vulnerability to earthquake.*
945 *Green – low risk, yellow – moderate risk, orange and red – high risk. Source: MMEIRS (2004)*

946 10. Volcanic eruption

947 The Taal volcano eruption in January 2020 generated silica that reached southern Manila and
948 Quezon City. Nevertheless, none of the cities along MANATUTI recorded an alarming high
949 coarse particulate matter (PM₁₀) value—Malabon even recorded a “good” air quality index of 28
950 (DENR, 2020). Mount Pinatubo in 1991 also produced ash that reached Metro Manila, albeit due
951 to a confounding typhoon at the time (USGS, 2016).

952 **Technological**

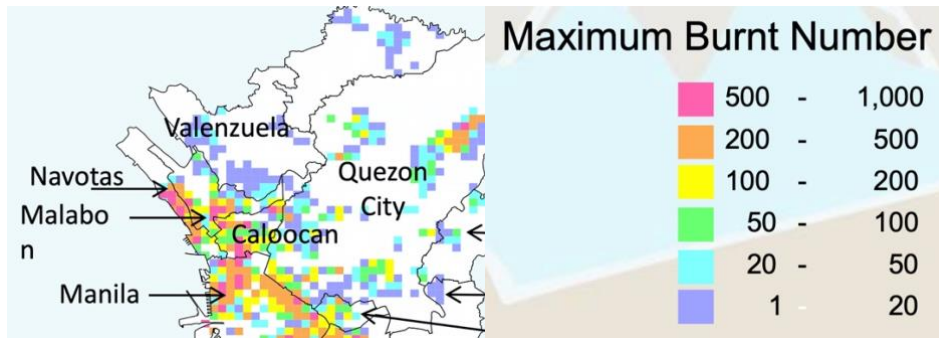
953 11. Fire

954 Slum areas are at greatest risk from fire hazards (Huq, 1999). Overlapping of industrial and
955 residential zones (Stott & Nadiruzamman, 2014). Anthropogenic hazards include fire. Poor
956 communities in the cities, with gridlock houses, light materials, and octopus wirings, are often
957 the victims. Electrical problems are the most common culprit, followed by lighted cigarette butt
958 and open flame, all residential factors (Mayuga, 2018). January to April is the time when most
959 fire incidents happen.

960 Quezon City remains to have the most number of fire occurrences in Metro Manila accounting to
961 20.6%, while Caloocan, Valenzuela, Malabon, and Navotas comprise 5.2, 2.4, 1.6, and 1.0%,
962 respectively. The three most destructive fire incidents in the country were in Quezon City and
963 CAMANAVA, namely, the Kentex Manufacturing Fire in Valenzuela City (2015, 74 casualties),
964 Manor Hotel Fire in Quezon City (2001, 75 casualties), and the Ozone Disco Fire in the same city
965 (1996, 162 casualties) (Bautista, 2018). Three areas in the region where fires regularly occur
966 are Kapiligan St. in Brgy. Doña Imelda (1 fire per year), NIA Road, Brgy. Pinyahan (1 fire within
967 3 quarters of a year), and Baseco Compound in Port Area, Manila (1 fire within half a year)
968 (Barrientos-Villarta, 2017).

969 Areas densely populated by informal settlers are pointed by BFP as “breeding ground” of fire
970 hazards (Villamente, 2017). However, less resources in firefighting are also seen as a problem,

971 as only 15 fire trucks are available for CAMANAVA's 255 barangays, for instance (Laude, 2010).
 972 A fire hazard mapping project, FireCheck, is still in the works, led by UP Cebu Center for
 973 Environmental Informatics and the DOST-PCIEERD (Nazario, 2019).



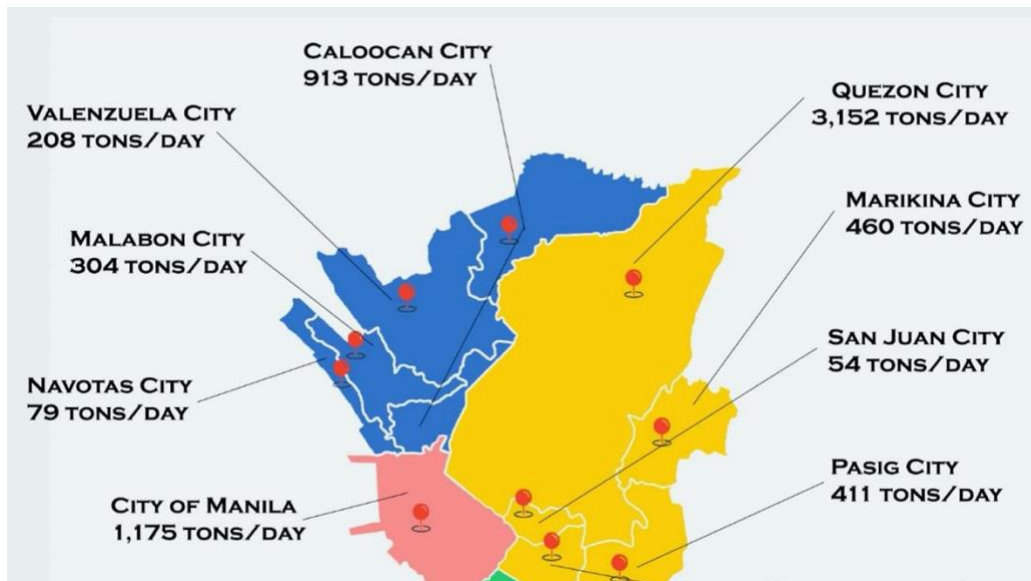
974

975 *Figure 28. Fire hazard map of northern Metro Manila showing the high flammability of western MANATUTI, especially*
 976 *Navotas, Malabon, Caloocan, and Manila. Source: MMEIRS (2004)*

977

978 12. Solid, liquid, and air pollutants

979 Other technological hazards that expose the river system to risk include the perennial urban
 980 problem—solid, liquid, and air pollution. Dump sites in Quezon City and Navotas may cause
 981 solid waste to leach and penetrate the groundwater, as shown in a preliminary analysis of deep
 982 wells around the Payatas dumpsite (Belen et al. 2019). This is apart from such site's direct risk
 983 to life, as in the Payatas tragedy of 2000 where its collapse caused the death of over 200
 984 residents.



985

986 *Figure 29. Comparative waste generation rate between cities in northern Metro Manila. Quezon City and Manila generate*
 987 *the highest amount of solid waste per day as of 2018. Source: DENR EMB (2019)*

988 Liquid and gas factory leaks in the industrial cities of Valenzuela and Malabon may also pose
 989 threat to health. Around 10% of air pollution in Metro Manila originates from stationary sources
 990 like factories and power plants (DENR EMB, 2018). Residents of Valenzuela have reported
 991 respiratory illnesses potentially linked with fumes from the nearby plastic manufacturing
 992 facilities in the city (Fonbuena, 2019). Meanwhile, the Tullahan river has been reported to
 993 contain a significant amount of coliform, higher than the tolerable value for a water body, which
 994 most probably originates from residential buildings, apart from the commercial establishments
 995 that also dump wastes into the river (Bonquin, 2019).

996 13. Substandard buildings

997 Substandard buildings have also been reported by the communities along MANATUTI to be a
 998 threat to life, especially when other hazards occur such as earthquakes. It was only in 2001 that
 999 the National Structural Code of the Philippines was crafted so many buildings that were built
 1000 prior did not take into account the existence of active faults in the region, apart from unchecked
 1001 constructions in highly populated areas. Indeed, western MANATUTI is assessed to sustain
 1002 heavy building damages following the Big One (MMEIRS, 2004).



1003

1004 *Figure 30. Building damage projection for northern Metro Manila given a Big One scenario. Notice the moderate (yellow) to*
1005 *high (orange and red) risks along the western portion of MANATUTI, with the eastern portion is at low risk (green and blue).*
1006 *Source: MMEIRS (2004)*

1007 **14. Shipping vessels**

1008 Shipping vessels along Navotas coast and the lack of a policing agency are also thought to be an
1009 additional hazard by residents. Aside from being the fishing capital of the region, Navotas also
1010 serves as home to huge shipyards for the ship repair industry, which caters especially to marine
1011 vessels (De Leon, 2012). Apart from the industrial waste such as oil that such industry
1012 generates, it may also endanger the lives of the fisherfolks directly by sea accidents or indirectly
1013 by scaring the fishes and other aquatic life where their livelihood depends.

1014 **Environmental**

1015 **15. Red tide**

1016 Paralytic shellfish poison (PSP), commonly called red tide, is an environmental hazard common
1017 to warm coasts with relatively still waters, such as the coastal barangays of Navotas and Manila.
1018 Red tides refer to the proliferation of single-celled organisms called dinoflagellates by the beach,
1019 often resulting in a reddish coloration of the water (Tacio, 2018). Its season usually starts by the
1020 end of the warm and dry months, like May, up to the beginning of the rainy season, like August

1021 (Cosgriff, 2000). Shellfishes like mussels, oysters, or scallops, as filter feeders, usually take in the
1022 organisms and when they are sold to and ingested by humans, may cause poisoning.

1023 **Biological**

1024 16. Urban pests

1025 Sewer rats (black rats), which carry diseases such as leptospirosis, abound in Metro Manila. The
1026 disease can be passed on to and infect humans through the eyes or open wounds through
1027 consistent floodwaters. Therefore, the low-lying western MANATUTI has higher risk of
1028 exposure to the diseases brought by these pests.

1029 17. Viral outbreaks

1030 Dengue virus outbreaks have been reported in Metro Manila a lot of times already. As of press
1031 time, the region is also grappling with the highest cases of coronavirus in the country. With the
1032 recent resurgence of eradicated viruses like measles and poliovirus due to vaccine scare, Metro
1033 Manila is in danger, especially that polioviruses may be obtained from water sources. Aside
1034 from fatalities, potential consequences of health outbreaks include public paranoia and unrest,
1035 ultimately adversely affecting mobility, livelihoods, and economy.

1036 **Assessment.** Communities in the river system face severe risk of compound hazards such as
1037 flooding exacerbated by sea level rise, ground subsidence, and storm surge, fire and liquefaction
1038 resulting from earthquake, and public health outbreaks made favorable by increasing
1039 temperature and environmental pollution, among others.

1040 Hazards that the MANATUTI river system is exposed to confound one another. Tropical
1041 cyclones, or even monsoon rains, especially with the accelerated climate change, produce

1042 copious amounts of rainfall that in turn gives rise to severe flooding and strong winds that gives
1043 rise to storm surge.

1044 The lack of natural barriers along the western coast of Metro Manila may also contribute to
1045 flooding and storm surges. Earthquakes may lead to liquefaction and fire.

1046 Flooding is the hazard with highest probability to occur in the landscape followed by storm
1047 surge followed by climate change related events, ground subsidence and lastly, earthquake
1048 related hazards. All cities can be affected with the hazards except for Quezon City where storm
1049 surge, ground subsidence and tsunami has a zero probability to occur. Overall, Quezon city has
1050 the lowest number of hazards and magnitude among the cities in the landscape followed by
1051 Valenzuela. Remaining cities share the same number of hazards present and its magnitude.

1052 *Vulnerabilities and Capacities*

1053 **Socio-economic.** Social, economic, and political conditions in a specific landscape plays an
1054 important role in building the disaster resilience of communities. Socio-economic and political
1055 conditions are the roots of different vulnerabilities that are needed to be addressed to reduce
1056 the risk of disasters (OXFAM,2012)

1057 *Table 2. Poverty incidence among families in cities along the MANATUTI river system. Source: PSA (2015, 2018)*

City	Poverty Incidence	
	2015	2018 (1 st semester)
1st district Manila	4.8	5.7
2nd District Quezon City (and other cities)	3.9	3.5
3rd District CAMANAVA	6.5	8.1
NCR	4.6	4.9

1058

1059 A generally increasing trend on the poverty incidence among families is observed in 2015-2018
 1060 (1st semester) for the cities in the MANATUTI landscape. Second (2nd) District where Quezon
 1061 City is located has the lowest record poverty incidence among the cities in MANATUTI
 1062 landscape. While Second (2nd) District, CAMANAVA area, have recorded the highest poverty
 1063 incidence. Both Manila and CaMaNaVa were recorded to have a poverty incidence higher than
 1064 the NCR average.

1065 *Table 3. Percent poor in cities along the MANATUTI river system. Source: NHTS-PR (2017)*

City	Percent poor household (%)
Manila	14.26
Quezon City	5.14
Caloocan	9.31
Malabon	8.29
Navotas	4.84
Valenzuela	6.86

1066

1067 In the 2017 National Household Targeting System for Poverty Reduction (NHTS-PR) or Listahan
 1068 of the Department of Social Welfare and Development 70,276 households are assessed as poor.
 1069 Manila has the highest number of percentage of poor households (number of poor over the total
 1070 number of households assessed) with 14.26% percent poor households. Navotas and Quezon
 1071 City on the other hand has a relatively low percentage of poor households.

1072 In terms of employment, in 2018 NCR was the highest unemployment rate compared with other
 1073 regions in the country. Out of the 60.6% of the labor force participation rate, 7.3% are identified
 1074 to be unemployed (PSA,2018). In the NHTS-PR data average of 6 out of 10 poor individuals age

1075 15 and above have been reported to have no reported occupation. The percentage of poor
 1076 without reported occupation has been uniform in the cities across the landscape.

1077 *Table 4. Percentage of poor individuals age 15 and above with no reported occupation.*

City	Total unemployed	Total poor	% Unemployed
Caloocan	30,713	49,475	62.07782
Manila	51,180	83,762	61.10169
QC	21,484	35,383	60.71842
Malabon	8,363	13,824	60.49624
Navotas	3,477	6,029	57.67126
Valenzuela	7,413	12,916	57.39393
			Mean= 59.90989

1078

1079 Among the assessed poor households, 10% do not own the house and/or lot where they are
 1080 staying or staying without the consent of the owner.

1081 Varying industries are also dominant in terms of number in each cities along the landscape.

1082 Most are belonging to the Micro, Small, Medium Enterprise (MSME) whileas Medium to Large

1083 Enterprise comprise only of <1. Table.. Shows the dominant industry per city and its number

1084 compared to other industries.

1085 *Table 5. Dominant industry in terms of number cities along the MANATUTI river system.*

City	Industry	Relative number of establishment in the city (%) (2015)
Quezon City	Retail	41.97
Caloocan	Retail	34.28
Manila	-	-

Valenzuela	Wholesale and Retail Trade	29
Malabon	Retail	26.47*
Navotas	Fishing	59.21

1086 *Source: 2013 City Comprehensive Development Plan

1087 Retail has built the majority of the economic activities along the landscape. having the most
 1088 number of establishments in the city. Navotas however, is the only city in the landscape with a
 1089 dominant number of establishments that is still in agriculture related activities with fishing
 1090 recorded to have more than half of its establishments.

1091 Cash-for-work under the Risk Resiliency Program Thru Cash for Work Activities for Climate
 1092 Change Adaptation and Mitigation program of the Department of Social Welfare and
 1093 Development (DSWD) –National Capital Region (NCR) are also being carried out in the
 1094 distressed communities along the landscape as intervention to provide temporary employment
 1095 during and after a natural or man-made disaster. The LGUs' Social Welfare and Development
 1096 manages the implementation of the cash-for-work program. Jobs included in the cash-for-work
 1097 program are activities related to disaster risk reduction measures such as clean-up of rivers and
 1098 esteros, tree planting, gardening and others.

1099 Based on the 2018 data of the DSWD-NCR, there are 19,682 beneficiaries of the Risk Resiliency
 1100 Program Thru Cash for Work Activities for Climate Change Adaptation and Mitigation program
 1101 from the six (6) cities along the MANATUTI River system.

1102 *Table 6. Ground water extraction persistence and availability of potable water to the urban poor along the MANATUTI river*
 1103 *system.*

City	Household ground water extraction (%)	Percent of poor with unsafe water source
Manila	0.5779563	37.4558
Quezon City	0.8870585	28.6403

Caloocan	2.341265311	31.4828
Malabon	0.777343342	40.1581
Navotas	1.08859845	47.2799
Valenzuela	2.036709117	41.7962

1104

1105 1. Education Sector

1106 Since the reenactment of the Philippine Disaster Risk Reduction and Management (DRRM) Act
 1107 of 2019 (RA 10121), various initiatives to mainstream DRRM in the education sector were
 1108 already been conducted in the landscape. The Department of Education (DepEd) Order No. 37
 1109 released in 2015, has defined the role of the basic education sector in the DRRM. The said DRRM
 1110 in basic education were built in 3 pillars namely Safe learning facilities, School Disaster
 1111 Management, and DRR in Education. (DepEd, 2015)

1112 On the DRR in Education, cities along the MANATUTI River System have already included the
 1113 different concepts relating to the DRRM, Climate Change Adaptation (CCA), and Environmental
 1114 Management and Restoration (EMR) in the basic education subjects. Particularly to elementary
 1115 to high school, topics on DRRM, CCA, are included in the discussion in Science, Social Science,
 1116 and in Music, Arts, Physical Education, and Health (MAPEH). For Senior High School (SHS), a
 1117 DRR subject is in place that discusses the basic concept of disaster risks, hazard, and
 1118 vulnerability. Topics that discuss practical skills such as the basic life support are also included
 1119 in the SHS.

1120 According to the participants in the FGD among the representatives of city schools, though the
 1121 DRRM are generally included in the basic education curriculum, teachers still have the

1122 prerogative to choose the topic that will be discussed in different subjects that result in varying
1123 topics that are discussed. Thus, participants viewed that there is a need for further
1124 standardization of the DRRM topics that are included in the subjects. Additionally, localization
1125 based on the situation and location of the schools and communities are also helpful in the DRRM
1126 education in the basic level.

1127 As part of the extra-curricular activity, schools also participated in the recent initiatives to
1128 clean-up Manila Bay according to FGD WQMA participants. Students are being mobilized in the
1129 regular coastal and in-land river clean-up. Some school based organizations in elementary and
1130 high school are being established to help in promoting the practice of waste segregation and
1131 recycling in schools such as in the case of Quezon City (Quezon City LGU, 2018).

1132 In terms of safe learning facilities, the DepEd have already set a standard design of school
1133 buildings for safety. However, buildings that are proposed by LGUs have different structural
1134 design. Though participants cannot conclude that the LGU proposed buildings are not
1135 structurally sound.

1136 Previous infrastructural development (Pumping stations, river walls, road development, and
1137 others) have also minimized the impacts of flooding in schools specifically in the downstream
1138 area of the landscape (Malabon and Navotas area).

1139 Contingency plans on schools along MANATUTI river system are already in place according to
1140 the FGD participants from the Division of city schools, however, there are still gaps in the
1141 implementation and harmonization of the schools' contingency plan to the contingency plan of
1142 barangay where it is situated.

1143 2. Health

1144 The Department of Health (DOH) in 2016 has recorded a mortality of 46,209 among the cities
 1145 along the MANATUTI River System. All cities have a uniform cause of death which is Heart
 1146 related diseases and Pneumonia.

1147 Table 4f. Shows the number of deaths per city and the percentage of deaths that are attended in
 1148 2016. Attended refers to the cases given medical care at any point in time during the course of
 1149 the illness which directly caused death. Medical care may either be provided directly by
 1150 a medical doctor or indirectly by allied health care providers, i.e., nurses and midwives who are
 1151 under the direct supervision of a medical doctor. Otherwise the case is categorized as
 1152 “death unattended”

1153 *Table 7. City health attendance data.*

City	Total	Attended		Not attended		Not Stated	
		Number	Percent	Number	Percent	Number	Percent
Manila	12,573	6,938	55.2	5,624	44.7	11	0.1
Quezon City	16,460	9,514	57.8	6,917	42.0	29	0.2
Caloocan	9,235	4,195	45.4	5,017	54.3	23	0.2
Malabon	2,389	957	40.1	1,430	59.9	2	0.1
Navotas	1,783	732	41.1	1,051	58.9	-	0
Valenzuela	3,769	1,836	48.7	1,929	51.2	4	0.1

1154
 1155 Quezon City has the highest number of cases that have been attended while Navotas has the
 1156 lowest number of cases, 57.8% and 40.1% respectively. Moreover, cities in the CAMANAVA have
 1157 recorded to have below 50% attendance.

1158 Variation in the percentage of attendance can be attributed to the varying capacities and
 1159 accessibility of hospitals present in each cities. Table 8 shows the overall number of hospitals in
 1160 each cities (public and private), Hospital Bed-Population Ratio* , and no. of health centers.

1161 World Health Organization (WHO) has recommended a standard of 1:500 Hospital Bed-
 1162 Population ratio for developing countries such as the Philippines.
 1163 Bed capacity is one of the vital points in assessing the level of preparedness of a certain area as
 1164 disasters may cause high demand of hospital attendance.

1165

1166

1167 *Table 8. Number of hospitals, health centers and bed capacity ratio of cities along the MANATUTI river system.*

City	No. Hospitals in the City	No. Government Hospitals		Overall bed Capacity		Hospital Bed-Population Ratio*	No. of Health Centres
		NGA	LGU	Government	Private		
Quezon City	40	16	2	5,606	4,394	1:294	65
Caloocan	11	1	2	346	529	1:1914	44
Manila	35	6	6				59
Valenzuela			1				48
Malabon			1				21
Navotas			1				11

1168 *1:500 national standard population-bed capacity ratio

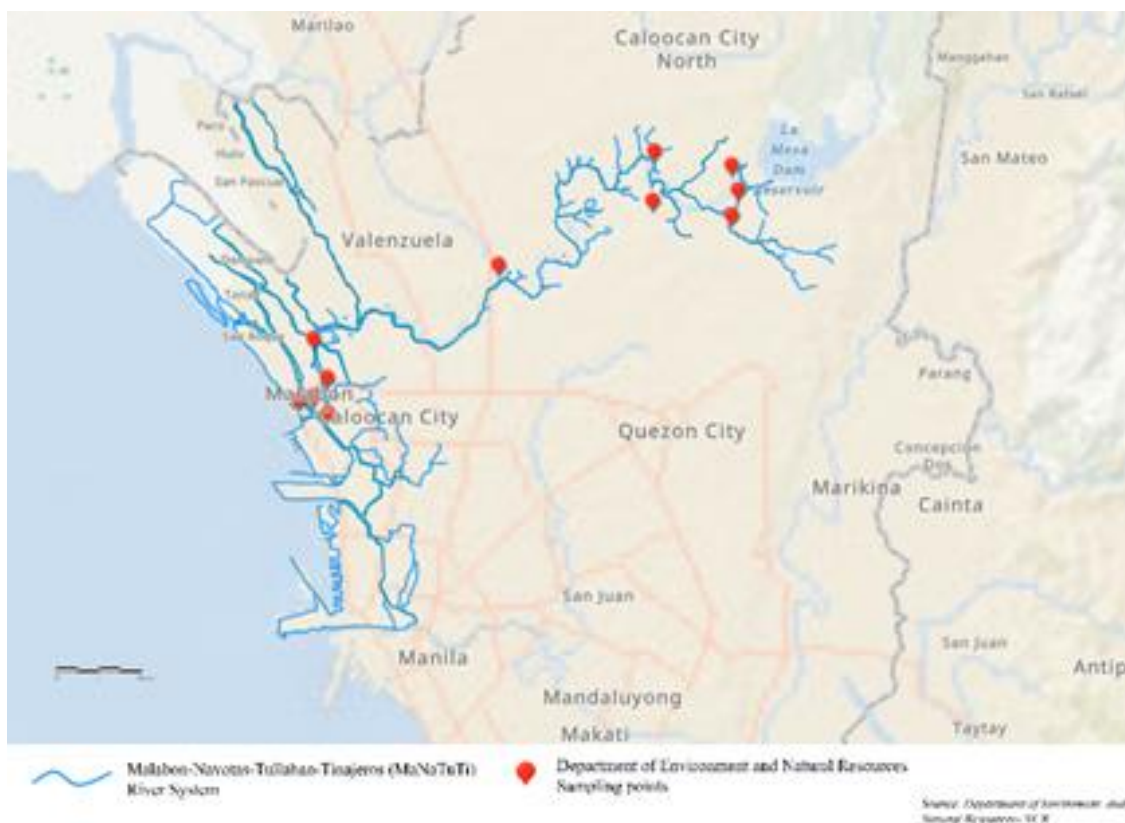
1169 City health departments are currently crafting and finalizing the Disaster Risk Reduction
 1170 Management on Health (DRRMH) that has been required recently by the DOH-Health
 1171 Emergency Management Bureau. However, according to the participants in the Health sector
 1172 FGD there is still no tool/guidelines given to the departments to assess the hazards including
 1173 non-disaster hazards such as outbreak of diseases.

1174 **Environmental.** The natural and sociological aspects of the river system may help mitigate
1175 risks or aggravate them.

1176 1. Current state of MANATUTI

1177 MANATUTI River System has remained to be classified as a Class C river. However, recent
1178 readings of its water quality parameters have remained to be below the standards set by the
1179 Department of Environment Natural Resources (DENR) Department Administrative Order
1180 (DAO) No. 2016-08 or the Guidelines and General Effluent Standards for Class C Rivers.
1181 According to DENR DAO 2016-08 Class C rivers are utilized as Fishery water for propagation
1182 and growth of fish and other aquatic resources, Recreational Water Class II (Boating, fishing and
1183 similar activities), and for agriculture, irrigation, livestock watering.

1184 DENR has established fifteen (15) monitoring stations along the river system (figure 31). The
1185 said agency are conducting monthly reading of thirteen (13) parameters (Table 9) annually.



1186

1187

Figure 31. DENR Sampling sites for water quality monitoring along MANATUTI.

1188

Table 9. Water quality parameters measured by DENR along the MANATUTI river system. Source: DENR Water Quality Monitoring Report MANATUTI WQMA

1189

Parameter	Standard (DAO 2016-08)
Biological Oxygen Demand (BOD)	7 mg/L
Dissolved Oxygen (DO)	≥5 mg/L
Color	75 TCU
Total Suspended Solids (TSS)	80 mg/L
Nitrate-Nitrogen	7 mg/L
Phosphate-Phosphorus	0.5 mg/L
pH	6.5-9.0
Temperature	25°C-31°C
Turbidity	No standard (Nephelometric Turbidity Units [NTU])
Salinity	No Standard (ppt)
Total Dissolved Solids	No Standard (g/L)

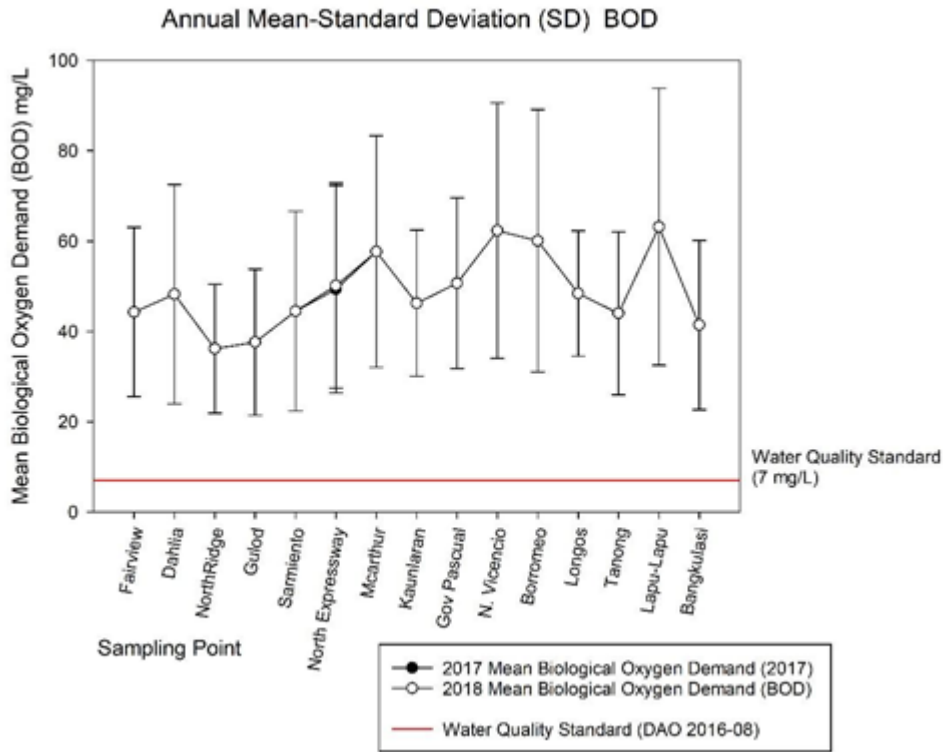
Conductivity

No Standard (millisiemens per centimeter [mS/cm])

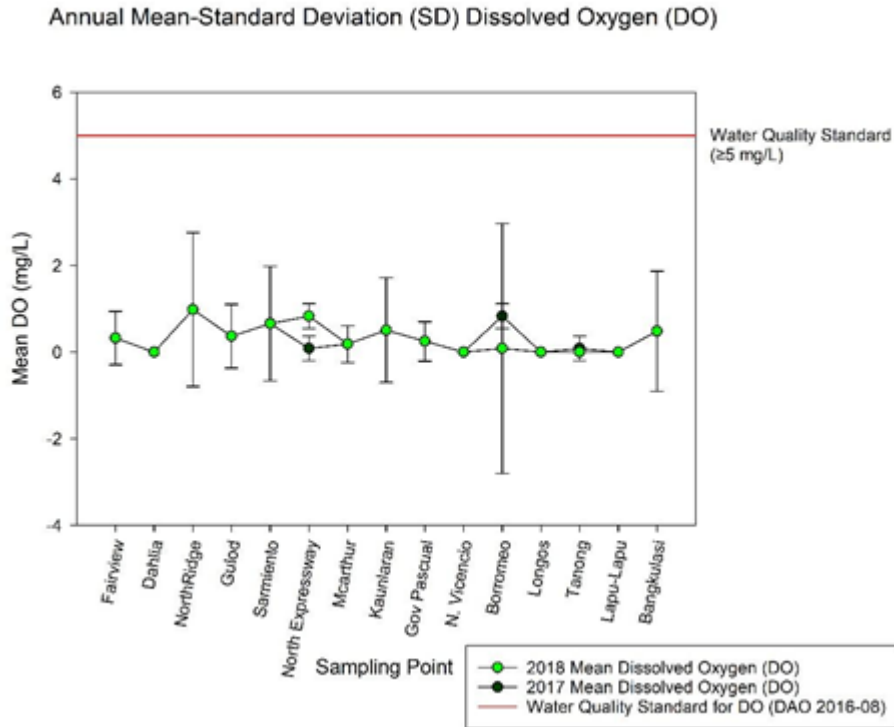
Fecal Coliform

200 Most Probable Number (MPN)/ 100 mL

1190



1191



1192

1193 *Figure 32. Annual mean standard deviation ($\mu \pm SD$) of Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) along*
 1194 *the MANATUTI river system for 2017-2018.*

1195

1196 All sites for DO and BOD were below the standard set for Class C water for both years.
 1197 Additionally, values in the sampling points reported for both DO and BOD in 2017-2018
 1198 overlapped due to the exactly the same DO and BOD readings gathered from the Annual Report
 1199 of the DENR Water Quality Monitoring Report Malabon-Navotas-Tullahan-Tinajeros
 1200 (MANATUTI) River System WQMA. Consequently, no significant difference($p < 0.05$) were
 1201 observed in the readings for DO and BOD for 2017 and 2018 (Figure 33 .)

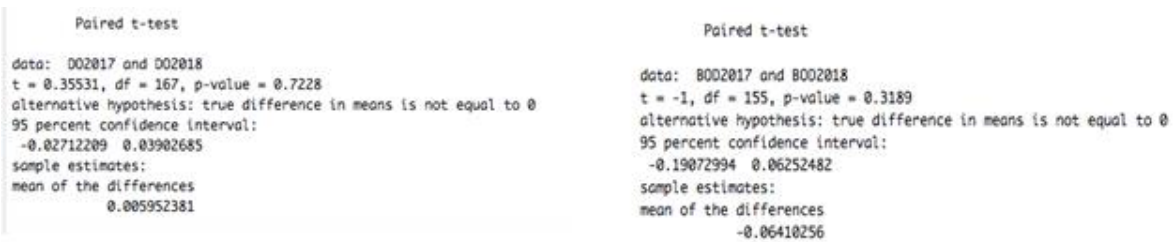
```

Paired t-test
data: D02017 and D02018
t = 0.35531, df = 167, p-value = 0.7228
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-0.02712209 0.03902685
sample estimates:
mean of the differences
0.005952381
    
```

```

Paired t-test
data: B002017 and B002018
t = -1, df = 155, p-value = 0.3189
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-0.19072994 0.06252482
sample estimates:
mean of the differences
-0.06410256
    
```

1202



1203

1204 *Figure 33. Relatively spread readings for all the plots (all coefficient of variation [CV] ≥ 1) also indicate a large variation*
 1205 *between the monthly reading of DO and BOD for 2017 and 2018.*

1206

1207 DO and BOD are important indicators of quality of a river. BOD indicates the amount of
 1208 putrescible organic matter present in the water body while DO measures the actual amount of
 1209 oxygen dissolved in the water. A high BOD value indicates a poor quality of water in a river. DO
 1210 decreases as the amount of BOD increase in a system (Encyclopedia.com, 2019). Depriving life
 1211 forms of available oxygen to survive. A below standard DO and BOD such in the case of
 1212 MANATUTI River System cannot sustain aquatic life forms in the river system.

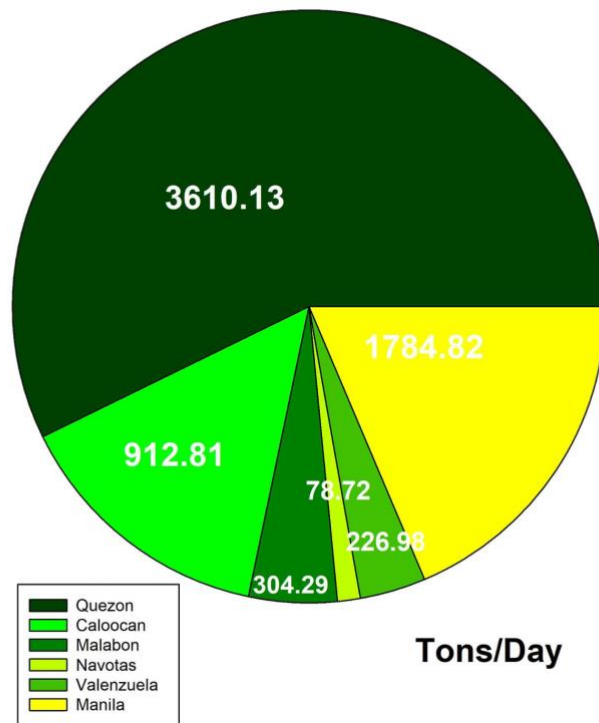
1213 In the case of overlapping value in the majority of the sampling sites and high CV, methodology
 1214 on sample collection, location, frequency of sampling, sample replication among others should
 1215 be reviewed in order to establish a more statistically accurate data for water quality in
 1216 MANATUTI River System. Specifically, DENR should look on the same reported value on many
 1217 sampling sites for different year.

1218 **2. Waste Generation and Management**

1219 According to the Water Quality Management Area (WQMA) members from the Local
 1220 Government Units (LGU) during the FGD session, there is still no Waste Analysis and
 1221 Characterization Study (WACS) conducted in the MANATUTI area covering all barangays in the
 1222 landscape due to the lack of necessary financial and technical resources. Cities are using the

1223 waste generation of the 10 year City Solid Waste Management Plan as baseline for crafting
 1224 programs and policies for their respective areas in MANATUTI.

Waste Generation of Cities along MaNaTuTi



1225

1226

Figure 34. Waste Generation of cities in MaNaTuTi landscape (MMDA, 2018)

1227 Quezon City being the largest city in terms of population and land area, has the highest waste
 1228 contribution along the landscape. This can have a significant impact on them the landscape due
 1229 to the location of Quezon City. Waste generated in the upstream can add up in the wastes
 1230 present in the downstream areas of the landscape.

1231

Table 10. Number of materials recovery facilities and diversion rate of cities along the MANATUTI river system.

City	Number of Materials Recovery Facility (MRF)	Diversion Rate (%)
Quezon City	60	52.67 ^a
Caloocan	111	35 ^b
Manila	-	58 ^b

Valenzuela	9	46 ^b
Malabon	3	51.41 ^a
Navotas	3	35 ^b

1232 ^aSource: City Ecological Profile (2015)

1233 ^bSource: Metro Manila Development Authority (MMDA) as per Asian Development Bank (ADB)

1234 (2014)

1235

1236 Republic Act (RA) 9003 or the Solid Waste Management Act of 2001 requires the Local

1237 Government Units (LGU) to have a Materials Recovery Facility (MRF) per barangay or cluster of

1238 Barangay and to have a minimum diversion rate of 25% of its annual waste generation. Waste

1239 diversion refers to activities which reduce or eliminate the amount of solid waste from waste

1240 disposal facilities.

1241 All cities in the landscape have passed the required diversion rate by the RA 9003. Quezon City

1242 has the highest rate of diversion rate among the cities along MANATUTI while Caloocan and

1243 Navotas has the lowest recorded diversion rate.

1244 In terms of the Number of MRFs all cities lack in the required number of MRFs per cities.

1245 Partnership with local junk shop are usually being done by the cities to compensate required

1246 number of MRFs such in the case of Malabon City. WQMA members said that the lack of

1247 available land for the additional MRFs are the biggest hindrance for the cities to achieve the

1248 required number of MRFs.

1249 **Infrastructural.** The built environment and structural development of the river system, as well

1250 as its contiguous communities, are important in analyzing the vulnerabilities and capacities of a

1251 landscape.

1252 1. Infrastructure Development



1253

1254
1255

Figure 345. Pumping Station and Flood Gate distribution of Major flood mitigation projects along the MANATUTI river system.

1256

1257

The first comprehensive flood control project for the Tullahan river was in 1997 by the

1258

Department of Public Works and Highway (DPWH). Financed by the Japan International

1259

Cooperation Agency (JICA), the project aims to build a flood control and drainage system in

1260

CAMANAVA area to mitigate the flooding. The project consists of structural flood mitigation

1261

measures: pumping stations, flood control gates, drainage facilities, channel improvements, and

1262

polder dike construction, among others (Muto, 2010). The project was completed in 2011.

1263

Although some polder dikes need to be raised and ripraps need to be constructed after

1264

riverbank structures have been toppled by Habagat (southwest monsoon) in August 2012

1265

(Muto, 2010; Romero, 2013).

1266 In 2013, Commission on Audit (CoA) conducted a performance audit in the mentioned project.
1267 The report concluded that the project did not completely mitigated the flooding cause by high
1268 tide and heavy rains. The project has failed to achieve its objective to reduce the flood level in
1269 the area from one (1) meter to below 0.5. CoA cited three reasons for the failure: the
1270 deficiencies in the structures, the existence of informal settlers, and large volume of garbage in
1271 the project sites, and inadequate personnel and communication facilities (COA,2014).

1272 In an interview with DPWH dated June 21,2019 , it was said that efforts are being done by the
1273 agency to address the mentioned concerns. Intervention on the current structures such as
1274 raising the river walls is being done by the agency to increase the efficacy of the project.
1275 Though, on the garbage issue, the agency said that regional and multi-agency effort are needed
1276 to address the concern. DPWH are working with various agencies in the rehabilitation of rivers
1277 of the Manila Bay area. Specifically, on probation of dredging equipment and in actual dredging
1278 conduct.

1279 On the concern regarding the presence of ISF around the flood mitigation projects as reason for
1280 the failure of DPWH's flood mitigation project, the lack of funds for right of way that can be
1281 utilized for the relocation of ISF that are affected by different flood mitigation projects have
1282 hindered their agency to address the discussed concern. The agency said that the relocation and
1283 housing concerns of ISFs are within the jurisdiction of LGUs and the National Government's
1284 Housing agency.

1285 2. Metro Manila and Surrounding Areas

1286 Flood Management Master Plan for Metro Manila and Surrounding Areas was crafted through a
1287 technical grant from World Bank under the Global Facility for Disaster Reduction and
1288 Recovery Trust Fund of the Australian Agency for International Development (AusAID) worth
1289 \$1.5 Million. The said master plan aims to provide sustainable flood management and serve as

1290 the roadmap of the government from 2012-2035 (23 years) (Commission On Audit, 2015). The
1291 masterplan concluded a 351.718B worth of 11 projects across Metro Manila and its adjacent
1292 areas.

1293 Included in the masterplan is a proposed Malabon-Tullahan River Improvement worth 21.535
1294 Billion pesos. The project is under high priority structural flood mitigation measure that aims to
1295 have a safety level of 50 year Return Period (RP) (DPWH DOCUMENT). As of 2018, only 14% of
1296 the needed budget for the Master Plan had been allocated due to other projects outside Metro
1297 Manila that are needed to be funded by the agency (Salaverria, 2018).

1298 Considering the need for immediate intervention, DPWH in 2013 allocated 5 Billion for 15 high-
1299 impact flood control projects under its ambitious Flood Management Master Plan for Metro
1300 Manila. Under this project is the KAMANAVA (Kalookan-Malabon-Navotas-Valenzuela) Project,
1301 Phase 1 worth P600 M. Included in the project is the rehabilitation of Catmon Creek and dike
1302 along NMTT. The project was already been declared as completed in the year 2015
1303 (DPWH,2015

1304 3. Locally initiated flood mitigation projects

1305 LGU have also carried out various initiatives to mitigate the impacts of flooding especially in the
1306 downstream and shore areas of the landscape. Navotas city has established pumping station
1307 which locally called as “bombastik” that are situated across the city (Figure 4.5) Bombastik
1308 propels out all the household waters and rain inside the containment structure, while the flood
1309 gates prevent the entry of water in the area during high tide. The flood gates were kept closed
1310 and the pumps were kept running during high tide which resulted in a decreased flooding in the
1311 locality.



1312

1313

Figure 36. More than 44 bombastiks are now distributed in the barangays of Navotas.

1314

1315 In the FGD among the selected communities of Malabon and Navotas, participants observed that
1316 the flooding frequency and severity within their communities have been minimized over the
1317 recent years. Participant attribute this to the flood mitigation projects that are constructed
1318 adjacent to their communities, especially those that are led by the local government. However,
1319 due to the localized characteristic of the bombastic, communities have reported that water
1320 pumped out in a specific area are only transferred to adjacent community and/or city.

1321 4. Early Warning System

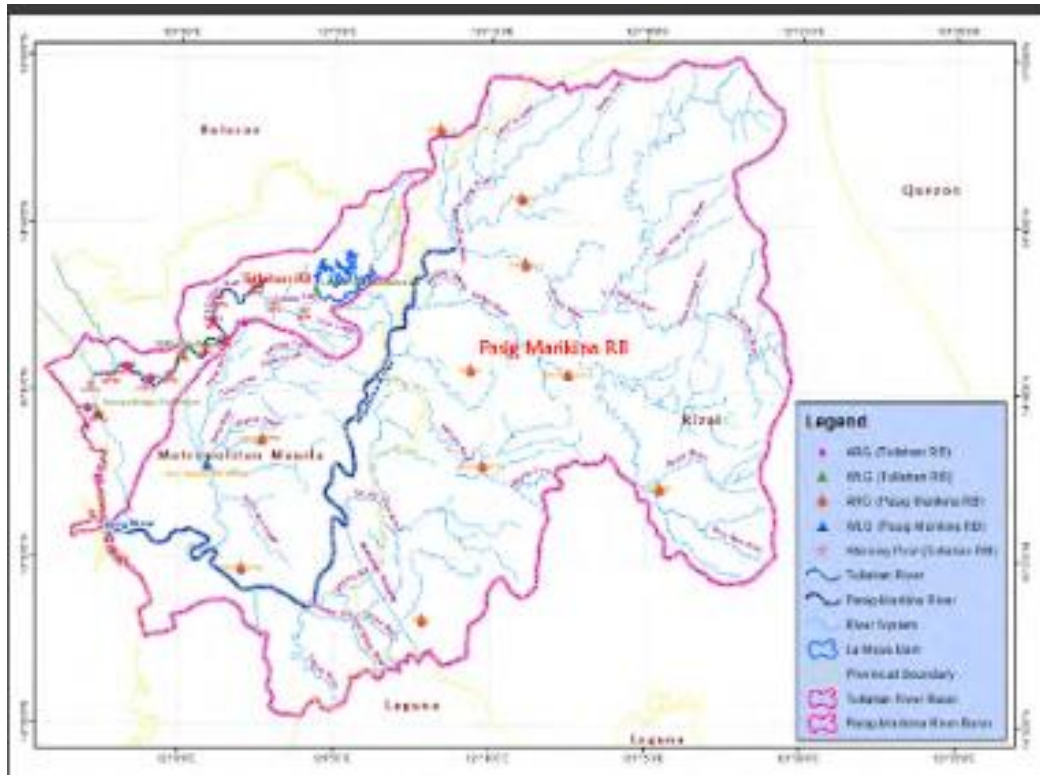
1322 Information on various natural hazards are primarily generated by two national agencies
1323 namely the Philippine Volcanology and Seismology (PHIVOLCS) and Philippine Atmospheric,
1324 Geophysical and Astronomical Services Administration (PAGASA). Wide array of platforms are
1325 currently being utilized by the National Government Agencies and Local Government Units as a
1326 tool to inform the communities on the risks along the landscape.

1327 5. Flood forecasting and Warning System

1328

1329 Considered as the most advanced early warning system for flooding present in the landscape is
1330 the Early Warning System 3 (EWS) of the Philippine Atmospheric, Geophysical, and
1331 Astronomical Services Administration (PAGASA). EWS3 is part of the partnership program of
1332 the Korean Government through the Korea International Cooperation Agency (Koica) and
1333 PAGASA for the Automation of Flood Early Warning System (EWS) for Disaster Mitigation in
1334 Greater Metro Manila Project. South Korea granted a \$5.2 million dollars for the establishment
1335 of a command center, equipment, provision and installation of automatic water-level gauges,
1336 automatic rain gauges, warning posts and others in the Pasig-Marikina and Tullahan River
1337 Basin.

1338 Located in the MANATUTI River system are three (3) rainfall gauges, four (4) water level
1339 gauges, five (5) CCTV stations, One (1) Relay Station and fourteen (14) warning posts in Quezon
1340 City, Caloocan, Malabon, Navotas and Valenzuela. Warning level for the forecasting points are
1341 determined thru a hydrographics survey (PAGASA,2017). Figure 4.6 shows the overall layout of
1342 EWS3 in both Tullahan and Pasig-Marikina River Basin .



1343

1344

Figure 357. Map of the early warning systems for the Tullahan River Basin (Peralta, 2016).

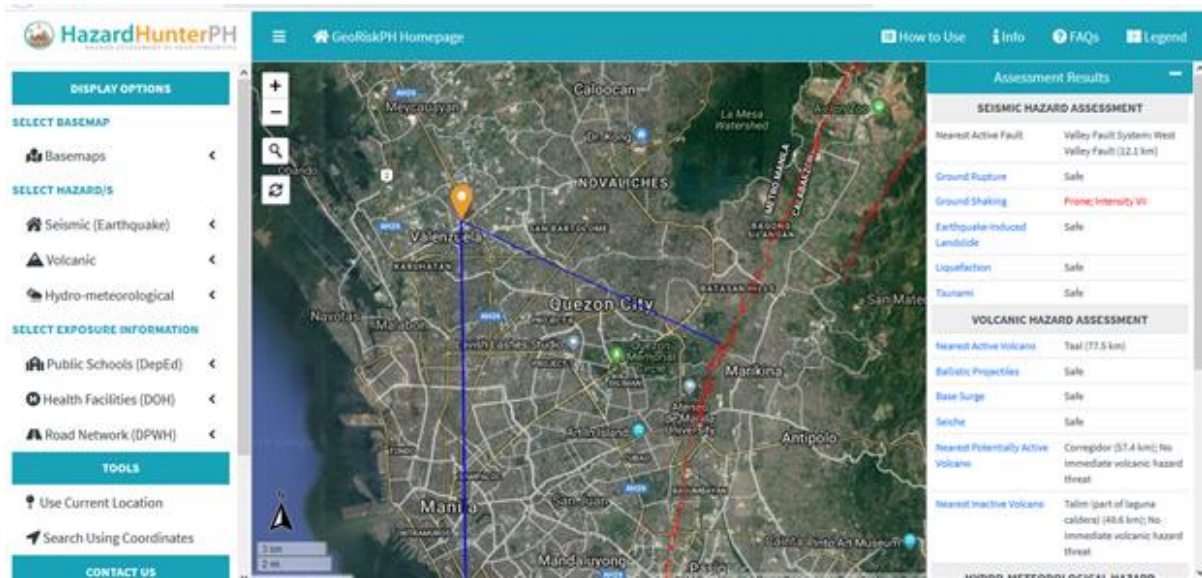
1345

1346 The reading in various remote sites are gathered through radio based communication and is
1347 being utilized through a software that is also part of the program.

1348 6. Use of Information and Communication Technology (ICT)

1349 The rise in the use of information and Communication Technology (ICT) in the recent years
1350 especially in urban areas such in MANATUTI landscape has opened an opportunity in Disaster
1351 Risk Reduction and Management. The real-time information gathering, dissemination, and
1352 analysis in various areas of Disaster Risk Reduction has been some of the advantages in the
1353 usefulness of ICT in DRRM (Sakurai & Maruyama, 2019)

1354



1355

1356

Figure 368. Interface of the HazardHunterPH. Source: GeoRisk (2019)

1357

1358 Led by PHILVOLCS, the GeoRisk Philippines has recently launched an application called
 1359 HazardHunterPH (Figure 4.7) that summarizes multi-hazards in the user’s chosen location
 1360 along with explanation and recommendation to further understand the present risks (Bagayas,
 1361 2019). Additionally, the application shows exposure information (public schools, health
 1362 facilities, and road network) that could help in analyzing risk in a specific area.

1363 According to the Department of Science and Technology (DOST) Undersecretary for Disaster
 1364 Risk Reduction and Climate Change Renato Solidum, PHIVOLCS will release more hazard related
 1365 applications in the coming days such as the Geomapper and Geoanalytics.

1366 Table 11. ICT platforms utilized by cities along the MANATUTI river system as warning system.

City	ICT Platforms for Warning System	
	Social Media and/or Website	LGU Generated Text Message
Quezon City	Present	
Caloocan	Present	
Manila	Present	

Valenzuela	Present	
Malabon	Present	Present
Navotas	Present	Present

1367

1368 Complementary to the traditional media, LGUs have also used social media to disseminate
 1369 information to its constituents. Warnings through a locally-generated text blast to constituents
 1370 were also been used by the LGUs.

1371 USec. Solidum recommends a uniform coding system in the processing of data related to DRRM.
 1372 A uniform coding will enable an easier integration of various data that are being generated by
 1373 different sources.

1374 **Governance.** The deciding people and their power dynamics across a landscape may not be far
 1375 from ideal.

1376 1. Existing Rehabilitation efforts for MANATUTI

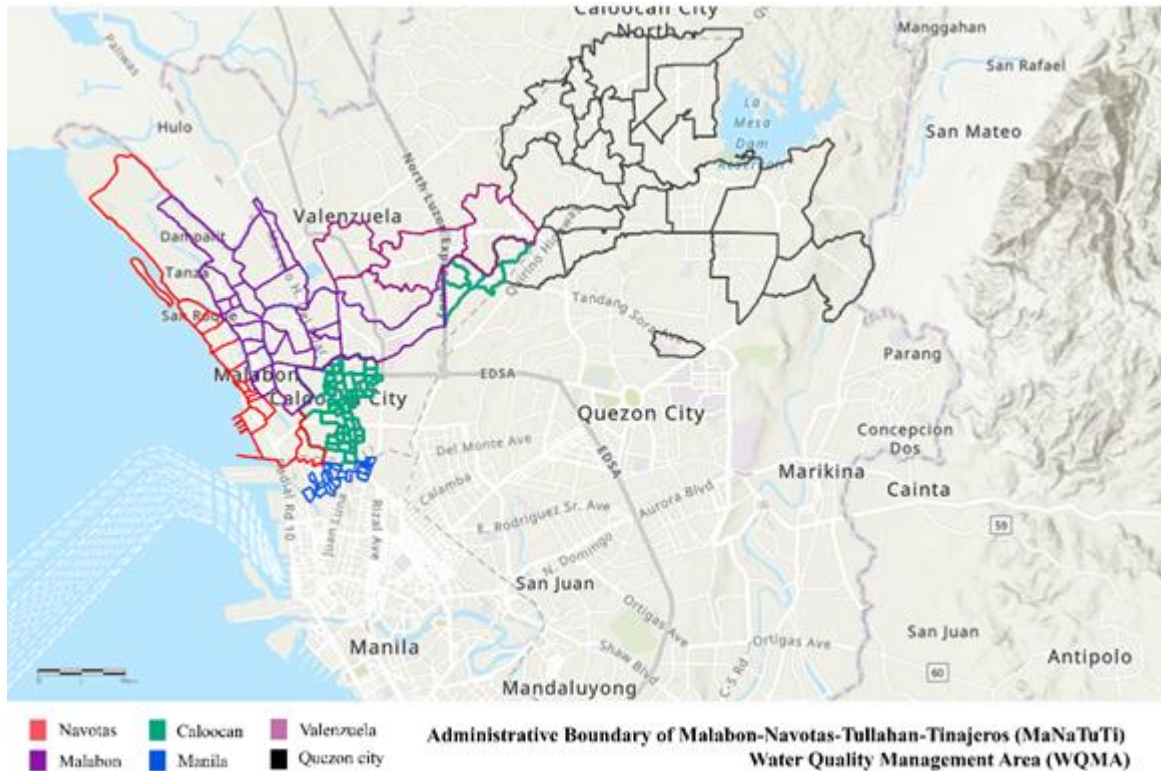
1377 New wave of efforts are being carried out to rehabilitate MANATUTI under the current
 1378 administration of President Duterte.

1379 a. The Water Quality Management Area (WQMA)

1380 Pursuant to the Philippine Clean Water Act of 2004 (RA 9275), a Water Quality Management
 1381 Area (WQMA) for MANATUTI River System was established in 2018 by DENR. This is a
 1382 concurrent initiative to the existing River Management Committee (RMC).

1383 WQMA serves as the physiographic based inter-LGU body that aims to improve the water
 1384 quality of MANATUTI through formulation and implementation of programs inherently related
 1385 on water resources, ecological protection, water supply, public health, and quality of life.

1386 Covering 148 barangays (Annex the list of barangay covered in WQMA) within six (6) cities,
1387 MANATUTI WQMA cover a total area of 8,910 hectares (DENR, 2018).



1391 MANATUTI WQMA has already placed its own governing board and have established four (4)
1392 clusters namely, Habitat and Resource Management, Solid Waste Management, Liquid Waste
1393 Management, and Informal Settler Families (ISF).

1394 Each cluster have already crafted its respective action plans. Some concepts and actions that
1395 aims to mainstream the landscape approach on Integrated Risk Management (IRM) have
1396 already been placed in the action plans of the 4 clusters.

1397

1398 b. WQMA Operations and Governance

1399 Many concerns were raised by the members of WQMA in different cluster during the Focus
1400 Group Discussion (FGD). The existing administrative set-up where the Malabon-Navotas river
1401 system and Tullahan-Tinejeros River system are managed separately and under a different head
1402 can lead to inefficiencies in planning and carrying out programs. WQMA members suggested
1403 that MANATUTI should be managed as a one whole landscape with single unified action plan.
1404 Additionally, lack of available resources dedicated for WQMA has been a major factor for the
1405 non-implementation and/or delay of various projects of WQMA indicated in their action plan.
1406 Resources outside the WQMA-LGUs (National government) are needed for the implementation
1407 of the action plans. Existing resources of the LGUs are primarily used in social service. Though
1408 there are resources for different programs on environmental protection, there are still no
1409 mechanisms in place for the LGUs to internally generate resources dedicated to the MANATUTI
1410 river system, let alone its landscape-wide management.

1411 Prior to the creation of WQMA, an existing River Basin Management Council under River Basin
1412 Control Office has already been established in the landscape pursuant to the Executive Order
1413 510, s. 2006. The said office was created under DENR with a mandate to “provide sustained and
1414 sustainable water to the entire country”. In 2009, EO. 816 was released expanding and
1415 specifying the mandate of River Basin Control Office “as the lead government agency for the
1416 integrated planning, management, rehabilitation and development of the country’s river
1417 basins”.

1418 Although both are under the supervision of DENR, RBMC has a different coordination
1419 mechanism and target output for the said river system. WQMA representatives which are also
1420 members of the RBMC suggested to streamline the mandate and action plan of RBMC and
1421 WQMA to avoid the redundancy in the required output and functions maximizing the limited
1422 human and financial resources of the LGUs.

1423

1424 2. Manila Bay Clean-Up and MANATUTI River System

1425 Being part of the 17 major river system inside the Manila Bay watershed area, MANATUTI is
1426 also covered in the Supreme Court Writ of Continuing Mandamus that compelled National and
1427 Local Government Agencies to address the pollution in Manila Bay. Manila Bay Task Force was
1428 created in February of 2019 to expedite the rehabilitation and restoration of the coastal and
1429 marine ecosystem of Manila bay. The DENR was tasked to be the chairperson of the said Task
1430 Force. (Office of the President,2019).

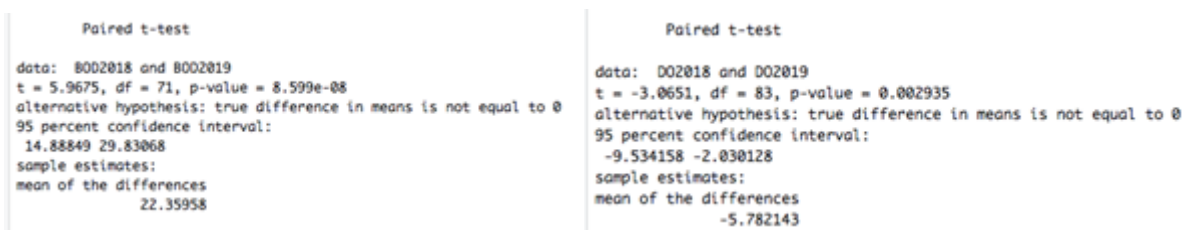
1431 Being the Vice-Chair of the said task force, Department of Interior and Local Government (DILG)
1432 are currently focus on mobilizing the Local Government Units (LGU) in cleaning-up Manila Bay
1433 and its in-land waters. DILG released a Memorandum Circular No. 2019-09 ordering the LGUs to
1434 participate in rehabilitating Manila Bay and to conduct a weekly clean-up drive (DILG, 2019).

1435 Private sectors have also participated in the clean-up activities. Largest of which is the 1-Billion
1436 pesos worth of dredging and clean-up activities for Tullahan River of San Miguel Corporation in
1437 a span of five (5) years (Lucas, 2019).

1438 Another strategy being employed by the national government for the clean-up of Manila Bay
1439 and its inland waters is the removal of Informal Settler Families (ISF). The national government
1440 allotted more than 50 billion for the relocation of Informal settler families along the waterways.
1441 However, there are differences in the delineation of easement on water ways based on different
1442 laws such as the Water code of the Philippines (3 meter easement) and the Supreme Court
1443 Mandamus on Manila Bay (5 meters) which resulted to the differences in the number of families
1444 that are needed to be relocated. Additionally, WQMA ISF cluster members also raised the
1445 varying implementation of the 50-B fund for the relocation of household along waterways.
1446 According to the participants, National Housing Authority (NHA) and the Social Housing

1447 Finance Corporation (SHFC) have offered different amount of amortization for housing units for
 1448 relocation. Moreover, the relatively high monthly amortization offered by the implementing
 1449 agencies of the 50-B fund are viewed by the WQMA ISF cluster representatives as deterrent for
 1450 families subject for relocation to accept the offered relocation. Lack of livelihood and social
 1451 service in the identified off-city relocation sites have also been a main consideration by the
 1452 families for not accepting the offered relocation.

1453 Since the commencement of the massive clean-up in Manila Bay, there is no formal assessment
 1454 on the effectivity of the said clean-up. A development in terms of the DO and BOD for the 1st
 1455 year of 2019 are observed compared to 2018 of the same period. . Figure shows the values of
 1456 BOD and DO for the first half period of 2019 and 2018



1457

1458 *Figure 38. There is a significant difference in both the means of BOD and DO for the 1st half of 2019 and in 2018 for the*
 1459 *same period.*

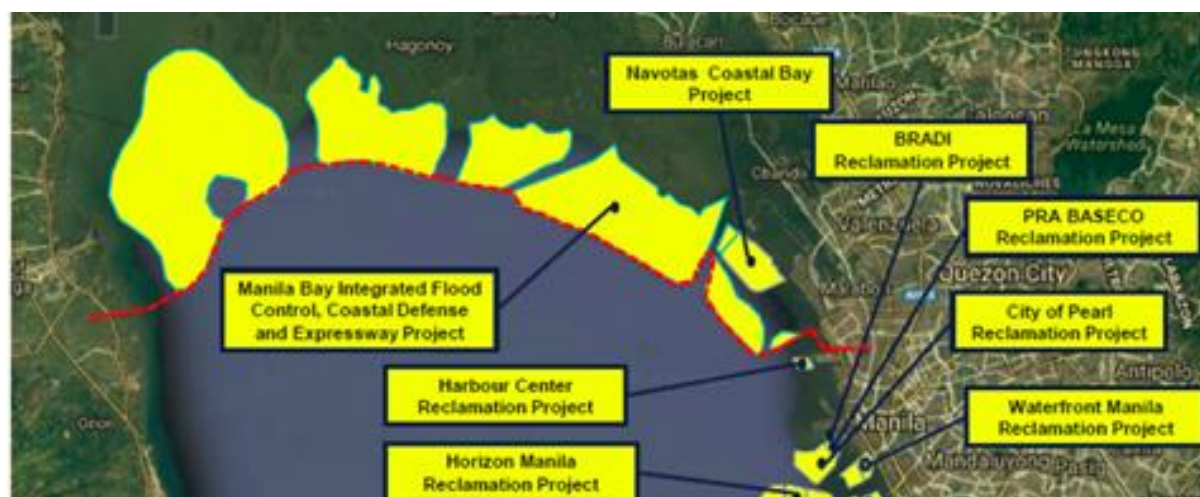
1460

1461 Though μ BOD level in all points has decreased the values are still above the standard set for the
 1462 BOD level for Class C river. DO on the other hand, has recorded to have a 10 out of 15 points
 1463 passed in the standard set for DO for Class C river. Thus, efforts to rehabilitate the river system
 1464 have resulted to improving water quality.

1465 WQMA members also raised some concerns on the conduct and coordination of the cleanup
 1466 activities lead by the DENR Central office in their respective cities. DENR Central lack in proper
 1467 coordination to Cities along MANATUTI has resulted to the difficulty of LGUs to prepare

1468 necessary resources, such as trucks, cleaning materials manpower and others has affected the
 1469 optimal efficiency and effectivity of the cleanup activities.

1470 4.2.5.3 Large scale projects and Programs in MANATUTI Landscape



1471
 1472 *Figure 39. Reclamation projects associated with portions of the MANATUTI river system. Source: Philippine Reclamation*
 1473 *Authority (2018)*

1474
 1475 One of the major change that could significantly affect the landscape is the proposed
 1476 reclamation projects in its shore areas. Total of 2,122.43 hectares (Ha.) are currently proposed
 1477 that are inside the cities along MANATUTI. In the shore area of Manila (1,432.43 Ha.) and in
 1478 Navotas (690 Ha.). Additionally, another 20,499. 57 ha. are also proposed that are adjacent in
 1479 the MANATUTI landscape (ANNEX).

1480 *Table 12. Proposed reclamation projects associated with the MANATUTI landscape.*

Project	Area (ha.)	Location	Details
Waterfront Manila Reclamation Project	318	Manila	Commercial and tourism hub in Roxas Blvd
Horizon Manila Reclamation Project	419	Manila	Commercial establishments

City of Pearl Reclamation Project	407.42	Manila	Deemed as Smart City, a central business district with residential, retail, entertainment, infrastructure complex.
Manila Solar City Project	148	Manila	Tourism, Commercial at Residential District, international cruise ship terminal
Manila Harbour Center	50	Manila	Expansion of sea port facility
Baseco Rehabilitation and Dev't Inc. (BRADI)	50	Manila	Commercial, residential, and other land use
PRA Baseco Reclamation Project	40	Manila	Commercial, residential, and other land use
Navotas City Coastal Bay Development Project	650	Brgy Tangos and Tanza, Navotas	Commercial/mixed use for business park
Eugenio Aguilar Reclamation Project	20	Navotas	Application stage

1481

1482 Manila LGU has already approved at least four (4) reclamation projects since 2018, Navotas on
1483 the other hand have already been given a Notice to Proceed (NTP) for the 650 ha. Navotas
1484 Coastal Bay Reclamation Project (NCBRD). Upon receiving NTP, companies can start its actual
1485 construction and operations on the ground. Recently, commencement of different construction
1486 activities for the reclamation project have also been reported.

1487 However, pursuant to the Section 6 of Executive Order (EO) No. 74 or the Holistic Approach to
1488 Reclamation, no reclamation project projects above five (5) ha. should proceed without
1489 undergoing an Environmental Impact Assessment (EIA) that assesses the cumulative impacts
1490 rather than the specific project basis. No existing reclamation projects have undergone said
1491 programmatic EIA.

1492 Communities along the shore areas of Navotas have raised concerns on the proposed
1493 “developments” in their areas as these are affecting their livelihood as fisherfolks. According to
1494 the communities, construction of road dikes aside from the proposed reclamation have blocked
1495 their fishing routes and boat landing area. Additionally, reclamation can also disrupt the areas
1496 where fish populations produce eggs. Based on a study conducted by Tobias et.al, high
1497 concentrations of fish eggs are found in Manila bay including in the adjacent areas of Navotas
1498 shoreline.

1499 Additionally, a study conducted by Rodolfo et. al, pointed out that reclamation in Manila Bay can
1500 aggravate the existing disaster risks in the area. Specific to the landscape, a 3-m storm surge can
1501 be generated in the coastal area of Navotas. Moreover, shore areas of Manila bay are also prone
1502 to earthquakes and its related hazards such as tsunami and liquefaction.

1503 3. Manila Bay Sustainable Development Master Plan (MBSDMP)

1504 Another program that can significantly affect the MANATUTI River system landscape is the
1505 crafting of the Manila Bay Sustainable Development Master Plan (MBSDMP) led by the National
1506 Economic Development Authority (NEDA). The Philippine Government partnered with the
1507 government of Netherlands develop a masterplan for sustainable development and
1508 management of the Manila Bay Area.

1509 The masterplan is expected to be released in 2020, however, participants of the FGD and KII
1510 have raised questions on the inclusivity and effectiveness of the planning process. A respondent
1511 from DILG said that in their experience, a ‘sense of ownership’ among the different local
1512 government units (LGU) is needed in order to craft and implement an effective plan. This ‘sense
1513 of ownership’ stems from the genuine consultation among the LGUS inside the Manila Bay Area.
1514 During the FGD among the representatives of LGU, an insignificant number of participants are
1515 knowledgeable on the process and content of the said master plan. Additionally, MANATUTI

1516 WQMA, which covers the environmental concerns of the MANATUTI River Systems was yet to
1517 be consulted by the NEDA.

1518 4. Governance and Disaster Risk Reduction

1519 The Disaster Risk Reduction and Management (DRRM) act of 2010 (RA 10121 requires the local
1520 government to allot less than five percent (5%) of the estimated revenue from regular sources
1521 shall be set aside as the LDRRMF to support disaster risk management activities. The varying
1522 revenue of cities along the landscape have also led to the difference in the capacity of the Local
1523 Disaster Risk Reduction Management (LDRRM) in each city. Quezon City and Valenzuela have
1524 relatively advanced capacities in terms of resources of the LDRRM.

1525 The existing mechanism used by DILG to assess the preparedness of cities is through the Seal of
1526 Good Local Governance (SGLG). Included in the evaluation for SGLG are Disaster Preparedness
1527 and Environmental protection performance of the city. From 2016-2018, Caloocan (3 years),
1528 Malabon(2 years), Navotas (2 years), and Quezon City(2 years) were awarded with SGLG.
1529 However, this existing mechanism to mainstream DRRM in cities are purely based on merit and
1530 awards. According to the DILG, there are still no mechanisms to exact accountability to LGU that
1531 carry out programs and policies that increase the risks in their city, such as implementing
1532 environmentally destructive projects or in case of an LGU that veers away from a previously
1533 approved Comprehensive Land Use Plan (CLUP) and Comprehensive Development Plan among
1534 others.

1535 Community-Based Disaster Risk Reduction in barangay level is also present in the landscape.
1536 Various Community Risk Assessment (CRA) carried out in the past years specifically in the
1537 CAMANAVA area has been vital to barangays in understanding the risks present in their
1538 communities. CRAs have paved the way in crafting Barangay Disaster Risk Reduction and
1539 Management Plan (BDRRMP) in various communities.

1540 Civil Society Organizations (CSOs) are also present in the landscape as mentioned by
1541 participants from LGU and communities, such as ACCORD, CARE, Mother Earth Foundation, Plan
1542 International and others have played an important role in assisting communities in building
1543 their own DRRM initiatives. According to the FGD participants from the LGU, CSOs' lobbying of
1544 new practice and principles on DRR are helpful in advancing their respective work. These
1545 organizations have provided technical assistance in developing disaster resilience and
1546 environment related plans and programs in LGUs present in the landscape. Such these are camp
1547 management training, crafting and aligning of city and barangay level DRRM plan, recycling
1548 process, evacuation drills, Alternative Temporary Shelter (ATS) system, and others.

1549



1550 *Figure 41. Photos of CSO programs implement in the landscape*

1551

1552 **Analysis**

1553 *Worst-case scenario*

1554 4.3.1.a Extreme hazards and climate projections in periods

1555 Communities in the river system face severe risk of compound disasters such as flooding
1556 exacerbated by sea level rise, ground subsidence, and storm surge; fire and liquefaction
1557 resulting from earthquake; and public health outbreaks made favorable by increasing
1558 temperature and environmental pollution, among others. Enduring heat and drought is also
1559 imminent.

1560 South Caloocan, Malabon, Navotas, and Manila are projected to be the most heavily damaged by
1561 a worst-case scenario of hydrometeorological, geological, technological, environmental, and
1562 biological hazards occurring all at the same time; or one or more hazard events triggering a
1563 series of other hazard events resulting in a compound disaster. This is due not only to the cities'
1564 coastal and downstream location, which highly exposes them to all water-, land-, and pollution-
1565 associated hazards, but also the sheer crowding per unit area and their high poverty incidence.
1566 A super typhoon towards the last quarter of the year with severe rainfall and extreme storm
1567 surge may submerge the communities around the river system remains a possibility, with a
1568 simultaneous Big One and its consequent liquefaction inducing widespread fire as aggravated
1569 by the river system's isolation from the rest of the region.

1570 *Urban resilience*

1571 1. Socio-economic

1572 Communities along MANATUTI are receptive to risk management efforts but are hindered by
1573 extreme poverty and powerlessness. Years of community-based disaster risk management

1574 (CBDRM) activities in the area have proven their capacity not only to adopt risk management
1575 principles and practices, but also incorporate them in their culture in a way that allows them to
1576 glean and document lessons once disasters strike. They are capable of conducting drills,
1577 capacity buildings, and training with and without their original project implementers. They
1578 have a sense of ownership of the IRM program in the communities as evidenced by the
1579 successful community risk assessments, contingency planning, and education efforts led by the
1580 Partners for Resilience and the MOVE-UP Project for almost a decade now, something that
1581 ensures the continuity and sustainability of resilience efforts in the area. All of these features
1582 support the claim that big populations are themselves a huge well where several other
1583 capacities spring from. There is power in number, especially if populations are seen as
1584 invaluable capital in enhancing the resilience of cities in the midst of climate change and
1585 environmental disasters.

1586 However, there is not much enabling environment where communities may foster optimal
1587 resilience from disaster. That the majority of the population residing along MANATUTI live
1588 under the poverty threshold speaks volumes about their vulnerability to disasters despite
1589 efforts to practice risk management. Public education is available and DRR efforts are
1590 incorporated in curricula but a great majority of the population still do not have access to it due
1591 to limited facilities and educators. Public health services are available but remain inaccessible to
1592 a vast majority, apart from the given limited facilities and health professionals.

1593 Finally, those with some knowledge of disasters have little participation in the decision-making
1594 processes. The urban poor, who are most frequently exposed to hazards and thus have a wealth
1595 of experience, are rarely actively consulted in governmental IRM efforts. Comprising the
1596 majority of the population, they should be able to modify the area and have authority on their
1597 water safety, as IRM efforts should be participative and tailored to local situations. Most of them
1598 lack land tenure and therefore suffer a constant fear of eviction, which cradle feelings of
1599 exclusion, fear, and mistrust. Poverty causes continuous movement of people, reinforcing

1600 insecurity in land use and poor urban planning. Livelihoods in MANATUTI must also be met in
1601 ways that alleviate poverty and improve nutrition of the communities but also conserve their
1602 environment. This means there must be a concerted effort to enjoin them in the discussion of
1603 learning, adaptation, improvement, tradeoff, negotiation, towards a people-centered IRM
1604 approach (Sayer et al., 2012).

1605 2. Environmental

1606 Communities upstream have a bigger role to play in reviving the ecosystems along MANATUTI
1607 that are nearing collapse. While Quezon City is the most developed economically and
1608 environmentally, with wider capacities for livelihoods and green spaces, it is also the biggest
1609 producer of solid and liquid wastes, most of which affect MANATUTI downstream. CAMANAVA
1610 and Manila, comprising the downstream, coastal communities are the most vulnerable to sea
1611 level rise and storm surge, but are the most disadvantaged economically. They are also the most
1612 vulnerable to health outbreaks due to cramped and overcrowded conditions, which further
1613 increase the demand for already inadequate utilities, poor water and sanitation services. Finally,
1614 the entire MANATUTI is exposed to similar but alarming levels of heat waves, bad air quality,
1615 threatening noise pollution, and short water supply in the years to come.

1616 3. Infrastructural

1617 The highly localized infrastructural planning that has been benefiting the most vulnerable
1618 communities must be extended and upgraded throughout MANATUTI for sustainability. While it
1619 is commendable that major flood early warning and control programs and infrastructures are
1620 located in CAMANAVA, similar parallel capacities must be extended throughout the landscape,
1621 especially upstream. Conventional disaster prevention, preparedness, and mitigation measures
1622 and equipment are present, including evacuation and refuge plans, draft boats, etc.

1623 However, there exists a need to gradually go beyond traditional sectoral engineering that is
1624 focused on fixed physical structures in MANATUTI. It must now consider flexibility,
1625 convertibility, and expandability in infrastructure building towards a more uncertainty-smart
1626 program in the landscape. On a larger scale, urban planning in general must also consider
1627 enhancing wind flow and removal of water across the landscape by selecting appropriate
1628 construction materials in shelters and buildings. Buffering areas and open spaces need further
1629 planning. Critical facilities need to be more mobile like modular evacuation shelters. The
1630 landscape must be rendered multifunctional, allowing for the construction of adjustment-
1631 capable infrastructure, several uses of buildings, alternative routes, inland transportation, crisis
1632 centers, health and housing education partner facilities in neighboring areas. All of these should
1633 be done with special attention to the utility of the urban poor, such as adequate alternative
1634 housing for them especially in times of disaster.

1635 On a smaller scale, while the culture of conducting CBDRMs is being conducted across many
1636 parts of MANATUTI, risk assessment must now be conducted on a zonal basis. Examples of a
1637 local resilience include streets that are lined with pegs for guide even during flooding, ensuring
1638 that residential houses have extra storage capacity and emergency supplies, improving the
1639 crowding in the area, alignment of houses, addition of hydrants, regularly maintained drainage
1640 systems, and more frequent and ecology-friendly disposal services.

1641 4. Institutional

1642 Comprehensive institutions that abound along MANATUTI may synergize their efforts for
1643 optimal impact. Collaboration and coordination must be facilitated in such a way that overlaps
1644 are avoided while gaps are filled in. With a heterogeneous population and its majority belonging
1645 to the urban poor, recipient context is important in the conduct and success of IRM programs
1646 across the landscape. Aside from conventional training and drills, other implicit forms of

1647 communication may be employed, such as regular and relatable information letters or public
1648 expositions, among others (Zevenbergen et al., 2008).

1649 While local government units (LGUs) exhibit fundamental knowledge of IRM, especially as
1650 applied to crafting local, climate-smart plans, capacity-building and technical support need to be
1651 strengthened by national government agencies. Not only will this further the science and ensure
1652 the effectiveness behind each LGU's plans, it will also ensure that planning, from prevention to
1653 contingency, will be viewed in a holistic, landscape-wide view. Finally, there is a need to enjoin
1654 the academic and research community along MANATUTI in the promotion of IRM in the
1655 landscape. Expert knowledge can be generated and must be integrated by both academic and
1656 research institutions and civil society organizations for a more comprehensive promotion DRR,
1657 CCA, and EMR among the communities across the landscape.

1658 5. Governance

1659 An integrative administrative and intersectoral formation that spans MANATUTI is in place but
1660 its legitimacy needs strengthening. Local governments across the landscape uphold a political
1661 consensus on the importance of IRM, especially in light of the past disastrous events that hit the
1662 district. They manage to incorporate IRM into their plans including evacuation, contingency, and
1663 comprehensive land use, and all the more manifest in the local climate change adaptation plan.
1664 Budget and resources are allocated to IRM efforts accordingly. National and regional legislations
1665 also enable more comprehensive risk management plans in the landscape and barangay
1666 governments, the basic unit of governance also show support and commitment to these plans.
1667 However, there remains a room for improvement in terms of mainstreaming IRM, let alone
1668 urban poor disaster resilience, into regular decision-making and routine policy-building. For
1669 example, while plans ensure the regulation of land use in a city, rules on permit provision to
1670 corporate entities or land developers do not necessarily match the land use plans. Law

1671 enforcement in land use is also biased towards political elites and corporate partners, but less
1672 towards vulnerable sectors such as the urban poor.

1673 Finally, the lack of operational governance guidelines and/or actual government entity has
1674 created various gaps in building inter-city or landscape wide disaster resilience. The organized
1675 relegation of responsibility and resources for IRM planning, how policies recognize the basic
1676 rights of people, and how quality is assured through honest audit mechanisms, remain to be
1677 seen in MANATUTI. This warrants a centralized but democratic system of governance, where
1678 popular participation in policy development and implementation is prime, and citizens and
1679 watchdog groups can demand for action and hold erring managers accountable. This is apparent
1680 in the mandated role of MANATUTI Water Quality Management Area Board to manage and
1681 monitor progress across the landscape and, inevitably, across several governmental
1682 jurisdictions. The Board can act like a central program office, as in the Room for the River
1683 program in a landscape in the Netherlands, the role of which evaluate the quality of designs for
1684 risk management plans across a river basin, facilitate and coordinate the regional projects for
1685 community building, and provide expert knowledge as well as political pressure to the central
1686 government. This is a centralized-decentralized form of governance that may be employed with
1687 MANATUTI WQMA Board at the center, but only if proper authority is given to them by the
1688 national, regional, and local governments.

1689 *Landscape approach*

1690 1. Adaptive management

1691 Adaptive management is being embedded in the local plans of the communities along
1692 MANATUTI but needs acceleration. Aside from CBDRM activities that utilize local traditional
1693 knowledge and experience such as disaster historicization, scientific projections are actively
1694 being integrated in local community disaster response plans. Trends in weather patterns, forest

1695 cover, land use, disaster frequency, and impacts are continuously evaluated. Aside from
1696 climatological and geological scientists, policy scientists are also regularly consulted for holistic
1697 planning and evaluation of programs in the area. These activities are led by many civil society
1698 organizations that have such technical and social expertise such as PFR. However, in addition to
1699 establishing regular ties with the academic and research community, civil society organizations
1700 must be able to synthesize their practical works and local-scale pioneering and experimentation
1701 to influence academic and research thrusts in the area and encourage cultivation of resilience
1702 through on-the-ground, bottom-up initiatives.

1703 There is also a need to go beyond introducing the principles of adaptive management among the
1704 communities. A culture of citizen science and local research among the communities themselves
1705 must be promoted to fully grasp adaptive management and successfully implement an
1706 uncertainty-smart disaster risk management program along MANATUTI. This will prevent the
1707 ad hoc practice of consulting natural and social science experts after a disaster has struck and
1708 lives and properties have been damaged already. For example, some research institutes are
1709 being involved in the disaster programs only when auditing and validating models and
1710 calculations. Active citizen science and local research among communities have an active role in
1711 accelerating experiential learning and continuous reflection, especially in light of the
1712 unprecedented increase in hazard frequencies and intensities.

1713 2. Cooperative stakeholders

1714 Intersectoral cooperation along MANATUTI is promising but needs realization. A potential
1715 effective jumpstart is coming up with a vision for MANATUTI that is shared by all sectors,
1716 organizations, and institutions that benefit around the river system. Different from a rural
1717 landscape, communities around urban river systems do not necessarily directly obtain their
1718 fundamental needs and public services from the water body, which has already been altered by
1719 human activities and technologies. If communities look at this angle, it will be difficult to arrive

1720 at a common goal for the river system, let alone care for it. However, lives and livelihoods
 1721 passively thrive within the urban river system and are indirectly connected and given security
 1722 by the river system. Communities need to imbibe this notion of connectedness through a
 1723 multifunctional landscape, from upstream to downstream, before varied objectives and
 1724 interests can be aligned and consensus on river system management among communities along
 1725 MANATUTI be made. Only through this future needs of stakeholders in the river system be
 1726 sustainably and equitable met.

1727 Once a common vision among stakeholders is shared, programs and policies must be planned
 1728 collectively to achieve this vision. These may start with agreements for cooperation, then
 1729 agreements for realization (Rijke et al., 2012). Collaboration and coordination between
 1730 community sectors, civil society organizations, academic and research institutions, private
 1731 sector, and government need to be improved not only to decrease tension and conflict but
 1732 maximize overlapping interests for synergies. For example, rights and responsibilities in a
 1733 coalition may be delineated in terms of land tenure, resolution of conflicts of interest, incentives
 1734 for collaborating actors. Finally, even if most technical and social expertise in disaster resilience
 1735 come from civil society organizations and academics and the private sector as well as
 1736 government are typically mere recipients of related training and efforts, the latter must also be
 1737 empowered to be active providers of disaster risk management endeavors to ensure continuity
 1738 of cooperation. This will happen only if the private sector and governments share the same
 1739 vision for a disaster resilient, climate-proof, ecologically healthy MANATUTI.

1740 3. Effective governance

1741 Multi-governmental efforts across MANATUTI are commendable but need centralization.
 1742 Supportive resource tenure and governance from national and local government agencies are in
 1743 place, primarily as reinforced by the continuing mandamus. Finance from both public and
 1744 private investors is also available. However, the duties of LGUs along the MANATUTI may be

1745 overlapping, and unclear roles and responsibilities usually favor disruption in governance
1746 efficiency. A central program office with inspired leadership and long-term commitment for the
1747 river system is necessary to execute and coordinate tasks at different local levels, provide
1748 guidance and a point of reference for the later phase of the risk management plans, and
1749 consolidate them for support at the national level (Rijke et al., 2012). Furthermore, while
1750 separate land use plans of LGUs generally incorporate IRM principles, water use plans need
1751 exploration as well. These may involve knowledge and practice on how different governmental
1752 scales across the landscape intersect, from catchment to sub-catchment, from international,
1753 national, regional, to local scales, from short to long term. Because water is a flowing and
1754 dynamic resource, a central program office that links the different cities, sectors, organizations,
1755 and institutions is more appropriate in managing the river system.

1756 The MANATUTI Water Quality Management Area (WQMA) Board best satisfies this necessity.
1757 The water board, aside from being a large communication office for early involvement within
1758 the community from the regional or national office, act as facilitator between the senior
1759 government, local stakeholders, and private sector (Zevenbergen et al., 2008). As in the Dutch
1760 Room for the River program office, the board may comprise dedicated river branch managers
1761 with collective sense of leadership who will serve as a central source of expert knowledge,
1762 establish link and interaction with local community project teams, and assist in discussions with
1763 decision-makers at national, regional, and local levels to bring together various stakeholders
1764 into achieving a common goal for the landscape (Rijke et al., 2012).

1765 Aside from uniting cooperative stakeholders, the board is also very important in fostering
1766 adaptive management among communities across the landscape. For example, it may
1767 consolidate initial assessments of the milestones of local risk management projects before
1768 progress is submitted for approval by the regional or national office. This also provides for
1769 timely action to facilitate improvements in the projects. Finally, a continuous adaptation of
1770 changing governance processes should also be considered in response to changing

1771 circumstances, especially in light of surprise disasters. Furthermore, the board may invite an
1772 independent team of experts from multiple disciplines to visit all projects for quality
1773 assessment and advice. Finally, a standalone budget must be allotted to the board not just for
1774 achieving water quality targets but also integration of water quality measures in their local
1775 contexts, alleviation of resistance from local communities, and security of maintenance after the
1776 measures are implemented.

1777 *Integrated risk management*

1778 Communities, led by civil society organizations and the local government units have started
1779 integrating climate change adaptation to disaster risk reduction efforts across MANATUTI but
1780 have yet to find opportunities to introduce ecosystem management and restoration as a longer-
1781 term risk-mitigating measure, especially on a landscape scale. Proof of this includes the relative
1782 recency of the creation of the MANATUTI WQMA Board, the issuance of the continuing
1783 mandamus that instructs local governments to monitor and improve water quality in Manila
1784 Bay, and the unchecked reclamation projects along the coast. Efforts of mainstreaming DRR
1785 through EMR can be observed in the WQMA. However, these efforts are still in the stage of
1786 planning and still need further implementation and development. Furthermore, MANATUTI still
1787 lacks a landscape wide manifestation of CCA in any governance level. CCAs are separated into
1788 independent city level plans. CSOs need to maximize these avenues to further promote EMR as
1789 an important new element for a more comprehensive and effective DRR in the district and in the
1790 entire region.

1791 Finally, from principles and lessons, DRR, CCA, and EMR need to be embedded in the working
1792 ethos of the communities, organizations, institutions, private sector, and local governments
1793 working across the MANATUTI landscape. From facts and figures, the anticipative, adaptive,
1794 absorptive, and transformative nature of IRM must manifest in the daily culture and behavior of
1795 the communities across MANATUTI for a more lasting and healthy resilience.

1796 **Conclusion**

1797 *The urban poor along the MANATUTI river system are the most vulnerable to disasters but have*
1798 *the least voice in the management of the urban landscape.*

1799 Poverty remains the biggest vulnerability of the majority of the people living along the
1800 MANATUTI river system as a significant proportion belongs to the urban poor. This means that
1801 a significant part of the population has no access to quality education, health, as well as disaster
1802 risk reduction programs. Changes in the landscape, be it natural or anthropogenic, have the
1803 most impact on their unstable livelihoods, which have always depended on the natural and
1804 social environment without any safety nets in cases of disasters. Integrated risk management,
1805 being in its primordial stage in the region and the country, is also still in the process of being
1806 infused into the people's culture, and unfortunately still requires a certain level of literacy.
1807 Owing to their direct interaction with their natural and social environment, the urban poor have
1808 the wealthiest traditional knowledge and practical experience, but wield the least power in
1809 disaster mitigation. However, they are left behind in many aspects of risk management,
1810 including access to structural and socioeconomic solutions and decision-making and
1811 governance. Many other stakeholders in the landscape still view the urban poor as origin of the
1812 problem instead of being part of the solution to reducing the impact of disasters.

1813 *The stakeholders of the MANATUTI river system remain to be disintegrated, their shares*
1814 *inequitable, and their managers unaccountable.*

1815 Management of the MANATUTI river system remains dependent on highly autonomous
1816 geopolitical units instead of a socio-ecologically oriented formation. This means that education,
1817 organization, and actions are highly sparse and localized, resulting in a risk management that is
1818 not done in unison. Despite the ethical and legal bases of a landscape-wide risk management
1819 that promises a rich and sustainable resource for its programs and sustenance, the discretion on

1820 how to run the program and allocate its resources remain in the hands of governing units with
1821 various priorities. As a result, the supposed integration of risk management across the
1822 landscape is hampered. Moreover, due to the lack of an authoritative structure for the
1823 landscape, specific functions of stakeholders also remain unclear. Civil society organizations still
1824 hold the only key to successful mainstreaming of integrated risk management, government
1825 units and people's organizations still lack ownership of the risk mitigation projects in their
1826 communities, while the academic and research community are still underrepresented. The lack
1827 of such working centralized formation also encourages unaccountability among the landscape
1828 stakeholders.

1829 *Integrated risk management along the MANATUTI river system needs more aggressive*
1830 *mainstreaming on the ground*

1831 Government units and communities are very receptive to the theory and practice of integrated
1832 risk management if only given the adequate and just resources, as evidenced by many success
1833 stories of capacity buildings with leaders as well as community-based disaster risk reduction
1834 programs. Many concerned civil society organizations and academic and research institutions
1835 that practice IRM also abound in the area for potential collaborations. However, while climate
1836 change adaptation has been equally successfully infused in many ongoing IRM programs,
1837 integrating ecosystem management and restoration needs more attention and work. In fact,
1838 most IRM programs in the area thus far are concerned with terrestrial ecosystems and the
1839 impact of land use changes on them, but not the equally significant aquatic ecosystems,
1840 including freshwater and marine. IRM programs also remain instructional instead of intuitive
1841 and cultural among people. Lessons from practice by many CSOs also need to be finally
1842 synthesized into new theories, which can further be developed into a more improved practice.

1843 **Recommendation**

1844 *Ensure that a decision-making platform is accessible to the urban poor in co-managing the*
1845 *MANATUTI river system.*

1846 Representatives of informal settler families and the rest of the urban poor need to consulted
1847 more in many programs for and decisions regarding the MANATUTI river system. They should
1848 be allowed to take decisive, even leadership, positions in policy-making bodies that will dictate
1849 their fate and that of the urban landscape.

1850 *Bestow more authority to landscape-wide formations to effectively govern the MANATUTI river*
1851 *system.*

1852 Centralized formations that recognize the existence of the urban landscape and the glaring need
1853 to treat it as such instead of a geopolitical entity shall be supported. An example of this
1854 environmental law- and ethics-based formation for the river system is the MANATUTI Water
1855 Quality Monitoring Area. The WQMA may serve as a centralized, bridging unit between the
1856 national-regional government and the local government units without being unilaterally
1857 influenced by any one of those levels. The MANATUTI WQMA experience of streamlining
1858 planning and operations of the WQMA and River Basin Management Council (RBMC) as
1859 landscape-wide formations covering the same physiographic unit should be further
1860 strengthened for efficient and effective risk governance of the MANATUTI river system. The
1861 experience could also serve as a model for other WQMAs/RBMCs in achieving coherence,
1862 effectiveness, and efficiency in the management of their respective river systems, which are
1863 ultimately interconnected to one another, including MANATUTI.

1864 *Actively influence stakeholders to adopt the integrated risk management framework along the*
1865 *MANATUTI river system.*

1866 Civil society organizations and IRM-practicing institutions shall tirelessly pursue partnerships
1867 with government units, the private sector, and people’s organizations, especially for a more
1868 ecosystem-oriented, climate-smart disaster risk reduction program. This will only be possible
1869 Doing this shall extend the efforts all the way to Manila Bay, where several “rehabilitation”
1870 programs have been and are still being planned.

1871 Mainstream the landscape approach in risk reduction planning and ensure its coherence across
1872 different levels of government, from barangay up to the regional or subnational scale, alongside
1873 mainstreaming IRM as overarching framework.

1874 The myopic, overspecialized, and exclusive view of hazards and consequently, the separate
1875 mitigation of their impacts, need to change. Flood, earthquake, and epidemic mitigation plans,
1876 climate adaptation, as well as environmental rehabilitation all need to be developed with a
1877 landscape-wide view, with special attention to their coherence, compatibility, and synergy. This
1878 will not only ensure that the governments, communities, and other stakeholders along the
1879 MANATUTI river system finally execute plans in unison, it will also foster exercise of their
1880 collective responsibility and accountability.

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