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10 UNDERSTANDING THE PERCEPTIONS, ROLES AND INTERACTIONS OF STAKEHOLDER  
11 NETWORKS MANAGING HEALTH-CARE WASTE: A CASE STUDY OF THE GAZA STRIP

12

13 ABSTRACT

14 The sustainable management of waste requires a holistic approach involving a range of stakeholders. What  
15 can often be difficult is to understand the manner in which different types of stakeholder networks are  
16 composed and work, and how best to enhance their effectiveness. Using social network analysis and  
17 stakeholder analysis of healthcare waste management stakeholders in the case study region of the Gaza  
18 Strip, this study aimed to understand and examine the manner in which the networks functioned. The  
19 Ministry of Health was found to be the most important stakeholder, followed by municipalities and solid  
20 waste management councils. Some international agencies were also mentioned, with specific roles, while  
21 other local institutions had a limited influence. Finally while health-care facilities had a strong interest in  
22 waste management, they were generally poorly informed and had limited links to each other. The manner  
23 in which the networks operated was complicated and influenced by differences in perception, sharing of  
24 information, access to finance and levels of awareness. The lack of a clear legal framework generated  
25 various mistakes about roles and responsibilities in the system, and evidently regulation was not an

26 effective driver for improvement. Finally stakeholders had different priorities according to the waste  
27 management issues they were involved with, however segregation at the source was identified as a key  
28 requirement by most. Areas for improving the effectiveness of the networks are suggested. The analysis  
29 utilized an innovative methodology, which involved a large number of stakeholders. Such an approach  
30 served to raise interest and awareness at different levels (public authorities, health providers, supporting  
31 actors, others), stimulate the discussion about the adoption of specific policies, and identify the effective  
32 way forward.

33

#### 34 KEY WORDS

35 Health-care waste management; stakeholder social network analysis; medical waste; sustainability;  
36 assessment method; identification of priorities.

37

#### 38 HIGHLIGHTS

39 A combination of stakeholder analysis and social network analysis was applied to understand health-care  
40 waste management in the Gaza Strip

41 The manner in which the networks operated was complicated and influenced by differences in perception,  
42 sharing of information, access to finance and levels of awareness

43 The research approach employed served to improve stakeholder involvement and raised awareness about  
44 the general situation of the system

45 The method could, with adaptation to the local context, serve to understand and enhance stakeholder  
46 networks in other similar contexts

47

#### 48 ABBREVIATIONS

49 EQA: Environmental Quality Authority; HCF: health-care facility; HCWM: health-care waste management;  
50 JSC: joint service council; MoH: Ministry of Health; MSW: municipal solid waste; PPE: personal protective

51 equipment; SWMC: Solid Waste Management Council; UNRWA: United Nations Relief and Works Agency  
52 for Palestine Refugees in the Near East; WHO: World Health Organization.

53

## 54 1. INTRODUCTION

55 It is widely accepted that the development and effective implementation of sustainable approaches to  
56 global challenges such as climate change and resource security require a holistic approach, involving a  
57 range of actors, including government, civic society, non-governmental organisations, and the community  
58 (Stern, 2006; Marias and de Almeida, 2007; Bodin and Crona, 2009; Weber and Allen, 2010; Phillips *et al.*,  
59 2011; Starkl *et al.*, 2013; Meadows *et al.*, 2014). However, there are several difficulties in achieving this  
60 holistic approach, including the identification of appropriate stakeholders, their effective engagement, and  
61 the achievement of some form of consensus during the development and implementation processes.  
62 Deliberative approaches (e.g. stakeholder forums and focus groups), have gained increasing prominence as  
63 a means of overcoming these limitations (Maclean and Burgess, 2010). They seek to gain the collective  
64 views of stakeholders (e.g. policy makers and individuals from the community), and incorporate them  
65 during the development of governance strategies (i.e. the overarching aims, objectives and mechanisms),  
66 to effectively develop and implement sustainable approaches (Chambers, 2003; Dietz *et al.*, 2003; Guntman  
67 and Thompson, 2004). While in theory there is an understanding of the mechanisms of deliberative  
68 approaches, in practice, real world case studies are limited (Levänen and Hukkinen, 2013).

69

70 Scientific literature presents several approaches to stakeholder participation. The Planning-Oriented  
71 Sustainability Assessment Framework (POSAF) utilises a constructivist approach (Roy, 2010; Starkl *et al.*,  
72 2013). While the Active Management strategy involves stakeholders working as a collective and in a  
73 structured way, to identify, implement and monitor selected strategies (Walters and Holling, 1990).  
74 Decision-making is often undertaken using Bayesian Networks (also known as Bayesian Belief Networks), to  
75 map out cause and effect scenarios, from different sources and data, which are then quantified to  
76 determine the extent to which one variable is likely to impact upon another (Jensen, 2002; Henriksen *et al.*,

77 2007). Another concept is that of Adaptive co-management (an expansion of co-management), whereby  
78 through collective discussion and negotiation, flexibility is built into the management of the social-  
79 ecological systems, to allow for adaptation in response to environmental change, and the acquisition of  
80 new knowledge by stakeholders (Carlsson and Berkes, 2005; Armitage *et al.*, 2009; Bodin and Crona, 2009).  
81 There are also bottom-up approaches, whereby stakeholders decide on the assessment criteria, including  
82 the Strategic Choice Approach (Friend and Hinckley, 2005; Lennartsson *et al.*, 2005), and Community-Led  
83 Urban Environmental Sanitation Planning (CLUES) (Simon *et al.*, 2004; Lundie *et al.*, 2006; Lüthi *et al.*,  
84 2011). However, various researchers argue that the fragmentation of stakeholders can often limit the  
85 success of bottom-up strategies (Linert *et al.*, 2013; Starkl *et al.*, 2013).

86  
87 The ecosystems-based management (EBM) approach to resource management involves an understanding  
88 of the entire ecosystem and the manner in which the social and environmental factors influence the  
89 resilience of the system and its ability to provide the required goods and services (McLeod and Leslie, 2009;  
90 Kidd *et al.*, 2011). An examination of the governance structures and the institutions involved in managing  
91 the ecosystem forms a key component of the EBM approach (Folke *et al.*, 2007; Hagedorn, 2008; Carollo  
92 and Reed, 2010; Cárcamo *et al.*, 2013). Within this context, identifying and understanding the perceptions  
93 and expectations of stakeholders plays a significant role in effective implementation of the EBM approach  
94 (Gelcich *et al.*, 2005; Pomeroy and Douvere, 2008).

95  
96 The development of strong networks can significantly enhance sustainable management of resources. For  
97 example, such networks have been shown to lead to more sustainable management of land resources,  
98 increased knowledge and motivation amongst stakeholders (Kilgore *et al.*, 2007; Larsen *et al.*, 2011;  
99 Meadows *et al.*, 2014), as well as enhanced engagement with marine protection areas (Heck and Dearden,  
100 2012; Lopes *et al.*, 2013; Cárcamo *et al.*, 2014), and mobilisation and allocation of resources (Carlsson and  
101 Berkes, 2005; Newman and Dale, 2007). Indeed, some argue that social networks are more important than  
102 formal governance structures for the effective enforcement and compliance with environmental

103 regulations (Scholz and Wang, 2006). For example, the development of effective health-care waste  
104 management (HCWM) policies at the national levels requires full stakeholder participation (de Titto *et al.*,  
105 2012). Indeed, by being proactive and working together, stakeholders, and in particular health-care  
106 facilities (HCFs), can improve their performances even if there is no legislative framework in place  
107 (Rushbrook and Zghondi, 2005).

108  
109 Use of deliberative strategies has been extensively employed within the field of environmental  
110 management (Hajer and Wagenaar, 2003; Baber and Bartlett, 2005; Dryzek, 2010). However, there is  
111 limited information about the ‘feedback mechanisms’ between institutions developing environmental  
112 governance or how best to facilitate a shift away from a spontaneous, self-organising model (Levänen and  
113 Hukkinen, 2013). Moving towards such an approach requires not only the effective sharing of information,  
114 but also that this knowledge is actively integrated into the new approaches. This is particularly true about  
115 engaging with relevant stakeholders for sustainable management of environmental resources during  
116 constrained circumstances (e.g. during armed conflicts or major disasters) (Mendenhall, 2014).

117  
118 Using the implementation of a new system to manage waste from health-care facilities in the Gaza Strip as  
119 a case study, this project set out to examine the strategies via which various stakeholders could best be  
120 engaged with the process. The Gaza Strip was chosen as there is limited empirical data on waste  
121 management in the area (Caniato and Vaccari, 2014). In addition, the decision was taken to focus especially  
122 on healthcare-waste management, due to the wider socio-economic and public health impacts of its  
123 management. For example, the ineffective management of health-care waste can lead to the risk of needle  
124 stick injuries and blood borne infections (WHO, 2011), as well as the spread of healthcare associated  
125 infections (Tudor *et al.*, 2010). The contribution of the study also lies in the methodological approach taken.  
126 Understanding how best to integrate the various actors across hierarchical levels and sectorial boundaries  
127 has traditionally been undertaken using either stakeholder analysis (Grimble and Wellard, 1997), or social  
128 network analysis (Kenis and Schneider, 1991; Crona and Bodin, 2006; Adam and Kriesi, 2007), or a

129 combination of the two (Reed *et al.*, 2009; Lienert *et al.*, 2013). Caniato *et al.* (2014) introduced a novel  
130 approach of stakeholder engagement and analysis, through the integration of stakeholder analysis and  
131 social network analysis. Such an approach was developed and tested for research purposes during the  
132 analysis of the infectious HCWM system in Bangkok, Thailand. This study employed an amended and  
133 improved approach to that used in Thailand. COOPI, an Italian NGO, asked CeTAMB to assess HCWM in the  
134 Gaza Strip, as evidence of ineffective management of the waste, linked in part to the on-going geo-political  
135 conflicts and the resulting humanitarian and public health impacts were present. This case study therefore  
136 offered the opportunity to improve the methodology, and to test it in a particularly complex environment.  
137 This paper describes this part of the assessment.

138

## 139 2. STUDY AREA: THE GAZA STRIP

140 The Gaza Strip is a narrow strip of land, bordered by Israel to the east and north, and Egypt to the south  
141 (Figure 1). It occupies a total area of 365km<sup>2</sup>. In 1948, it had a population of less than 100,000 people, but  
142 by the time of this study had 1.6 million and is expected to grow to 2.1 million by 2020, and 3.2 million by  
143 2040 (UNoPT, 2012; PCBS, 2013).

144

### 145 FIGURE 1

146

147 As a result of the armed conflicts in the region, management of the physical environment in the Gaza Strip  
148 has been severely neglected. Waste management faces a number of restrictions, including (UNDP, 2012;  
149 Salem, 2013):

150

- 151 - Limited national and local legislation
- 152 - Political and security instability
- 153 - Limited funding
- 154 - Inadequate infrastructure, including space for facilities

155

156 In addition, household waste arisings are expected to rise from around 1,506 tonnes per day in 2011, to  
157 approximately 3,383 tonnes per day in 2040 (UNDP, 2012).

158

159 At the time of the study, waste was being managed by five main providers, namely: (i) North Gaza Joint  
160 Service Council (JSC), (ii) the Municipality of Gaza, (iii) Deir al Balah JSC, (iv) the Municipality of Rafah, and  
161 (v) the United Nations Relief and Works Agency (UNRWA). The JSCs are also called solid waste management  
162 councils (SWMCs). Waste was primarily collected using donkey carts, in addition to tractors, tipper cranes  
163 and trucks. The salaries of the collection crews were paid by the municipalities, with additional support  
164 from the JSCs, and international agencies (Salem, 2013).

165

166 Out of the three main disposal sites in use, only one was lined and equipped with a leachate treatment  
167 system. Unfortunately the landfill had already exceeded its maximum capacity. Several dumpsites were  
168 used as transfer stations, where waste was temporary stored waiting for the money for the haulage.

169 Recycling and composting activities are very limited (Caniato and Vaccari, 2014). Few data are available  
170 about industrial and health-care waste, and only a small part of the waste is segregated and properly  
171 treated (UNDP, 2012). In particular the HCWM system is inadequate in all the hospitals, and it is generally  
172 open dumped with MSW (oPt Health and Nutrition Cluster, 2012). The legislative framework is incomplete,  
173 and at the HCF level, policies are not well defined (Al-Khatib *et al.*, 2009). In addition, the health staff lack  
174 awareness and training (Sarsour *et al.*, 2014).

175

### 176 3. MATERIAL AND METHODS

177 Based on Caniato *et al.* (2014), semi-structured interviews were first conducted with stakeholders who  
178 were evidently involved, like public authorities and the largest hospitals and clinics. Other participants were  
179 then identified using a snowball method (Alameddine *et al.*, 2011). A total of 16 structured and two semi-  
180 structured interviews were conducted. The interviewees were drawn from six public HCFs, three non-

181 governmental HCFs, five public authorities, three international actors, and one private non-health actor.  
182 None of the academics working in the field of HCWM could be clearly identified, and so they were not  
183 included. The HCFs chosen had among the largest number of patients according to World Health  
184 Organization (WHO) data (unpublished) and represented all five governorates in the Gaza Strip, and the  
185 different service providers.

186

187 Local staff translated all the questions from English to Arabic, when required, and gave explanations, where  
188 required. Both the interviewer and the translator took notes and debriefed after each interview, and at the  
189 end of the data collection process. Stakeholders were grouped into four main categories, namely: (i) public  
190 authorities; (ii) health providers (e.g. from HCFs); (iii) supporting actors (e.g. from the international  
191 community); (iv) others. The last category includes all the stakeholders not previously considered, but  
192 involved in HCWM due to other reasons, such as on contract (e.g. private contractors), education/research  
193 (e.g. academia), and due to the potential health impact (e.g. local community).

194

195 The following four key research tools as proposed by [Schmeer \(1999\)](#) were adapted to the case study  
196 according to [Caniato et al. \(2014\)](#): (i) Questionnaires; (ii) Stakeholder tables; (iii) Definitions of stakeholder  
197 characteristics with instructions to complete the stakeholder table; and (iv) Scoring scales for  
198 quantitative/close questions (Table 1). Thus interviewees had to give scores to different topics according to  
199 their point of view.

200

201 TABLE 1

202

203 However, in this case study some modifications were introduced in the methodology. For example, some  
204 questions were simplified, and fewer scores were requested; the scoring was limited to a scale of 1-5; each  
205 interviewee drew his own stakeholder network, and information network; and a draft program of  
206 intervention for infectious healthcare waste (HCW) was proposed and discussed with each stakeholder,



207 who gave his opinion of it, and evaluated the priority of each HCWM step. These HCWM steps were  
208 nominally classified as: (i) HCW production (waste minimization, green procurement), (ii) waste segregation  
209 (procedure and training), (iii) material for first storage and cleaning (e.g. bins and sacks for colour coding,  
210 trolley and personal protective equipment (PPE)), (iv) onsite storage (closed and protected containers), (v)  
211 collection and offsite transport (dedicated vehicle, clear collection schedule), (vi) treatment plant (possibly  
212 outside the community), and (vii) appropriate residue disposal. The program was explained using a visual  
213 description of the waste management flows suggested, and the actions required. Each stakeholder  
214 expressed their priority by placing between 1-9 tokens on each step. On average, five tokens were used,  
215 thus giving a total of 35 tokens. The higher the number of tokens on each HCWM step, the higher the  
216 priority attributed to the step.

217 Based on [Caniato et al. \(2014\)](#), stakeholders were analysed with respect to their: knowledge about HCWM  
218 and the situation in the Gaza Strip; interest in HCWM and the program proposed; attitude towards such a  
219 program; power and leadership; and level of interaction with other actors. The scores were triangulated  
220 with qualitative answers, and some modified to ensure consistency. Then scores about some topics were  
221 recoded to facilitate visual representation (Table 1).

222 Finally some stakeholders were grouped together and considered as a unique actor (e.g. different MoH'  
223 HCFs). The overall social network map of information and contacts were created by merging all the maps  
224 drawn by the interviewees. Such networks considered both the sources of information and stakeholders as  
225 nodes, and the relationships between them as 'oriented ties'. These arrows indicate the direction of the  
226 flow of information/relation. In some cases, they were double-headed, and report the scores as declared by  
227 the interviewees. Thus the ties are oriented from the interviewee to those who were nominated, while the  
228 information is oriented from the source to the receiver (i.e. the interviewee). When some actors were  
229 merged to represent one group (e.g. MoH HCFs), the strengths of each tie was the mean of those  
230 attributed by these interviewees, thus some calculations resulted in decimal numbers. Social networks  
231 were graphically represented with the use of UCINET ([Borgatti et al., 2002](#)), a well-know and regularly used  
232 software ([Long et al., 2013](#)). Priorities declared were aggregated in two ways, namely: (i) with the

233 calculation of the arithmetic mean of all the scores attributed, and (ii) counting how many times the highest  
234 priority was attributed to each step.

235

## 236 4. RESULTS

### 237 4.1 Stakeholder analysis

238 The interviewees stated that the Ministry of Health (MoH) was the most important stakeholder. It has a  
239 very complicated and branched structure, thus it was difficult to identify specific Directorates involved in  
240 HCWM, even after asking MoH employees. Other evident public stakeholders were municipalities and the  
241 SWMCs, as the authorities in charge of waste collection, and the Environmental Quality Authority (EQA),  
242 which replaced the Ministry of the Environment. Some ministries were only nominated once. Municipalities  
243 were sometimes also considered as the authority in charge of community wellbeing. Interviewees also  
244 nominated the hospitals and clinics of other health service providers (e.g. NGOs), private companies, and  
245 the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA). Finally, the  
246 WHO, other international supporting actors (e.g. UNDP, NGOs), the media and local community, and  
247 private contractors in charge of cleaning within the HCFs were sometimes mentioned. The WHO was  
248 considered separately to other international organizations because it was viewed as a reference for  
249 standards and guidelines by the interviewees. Only two stakeholders acknowledged universities and other  
250 sources like pharmacies.

251

252 None of the stakeholders identified looked to have any significant power regarding HCWM, and only the  
253 MoH and the municipalities/SWMCs had both resources and strong leadership. However, both of these  
254 agencies lacked financial resources. The MoH's power was limited by its fragmented structure, and the lack  
255 of a clear distribution of duties and responsibilities about HCWM. Among all the others, WHO had some  
256 influence, due to the technical support provided to the MoH and HCFs, as well as its coordination role. Non-  
257 governmental HCFs could affect at least their own practices, and tried to establish some cooperation with  
258 the governmental ones. The local community had some influence over the decisions of public authorities,

259 and were quite interested about HCWM, and in particular about incineration and the presence of sharps in  
260 the general waste street containers. Indeed, frequent complaints were received by the Al Shifa and Nasser  
261 Hospitals, where the majority of segregated HCW were incinerated. Despite the evident interest, all the  
262 other stakeholders had limited power, and did not feel able to affect HCWM. UNRWA was focused on its  
263 own roles, without paying attention to the general HCWM situation. Health NGOs provided regular training  
264 about specific aspects to both MoH and HCF staff, but they were neither particularly interested, nor  
265 coordinated about HCWM practices, thus their impact was limited. Private contractors involved in cleaning  
266 and HCW collection were very keen to be involved, but were bound by the contract signed, and did not  
267 have any influence on the system. Some actors (e.g. other ministries), were secondary, without any  
268 practical role. Academia could potentially affect health staff education, and provide technical support to  
269 the MoH, but HCWM was not a topic that the universities in the Gaza Strip had any significant expertise in  
270 or knowledge of. Finally all the stakeholders, except the municipalities/SWMCs did not have a clear picture  
271 of the situation, and had information only about some parts of the system (Figure 2).

272

273 FIGURE 2

274

275 All the interviewees had a positive opinion about the program of intervention. The EQA stated that HCWM  
276 was important, but not one of their top priorities, while the health NGOs expressed some interest, but this  
277 was dependent on their required level of involvement. However, all the HCFs expressed both an interest  
278 and very good opinions, despite their limited level of theoretical knowledge about HCWM. None of the  
279 interviewees stated that they had a sound knowledge about practices and impacts of HCWM, and all  
280 required more training and information. The stakeholders showed an interest and a positive attitude  
281 towards the improvement program, as they were involved in practical activities, like producing HCW or  
282 being in charge of some management aspects. The need for interventions was strongly recommended by  
283 all, as confirmed by their enthusiasm about the program proposed (Figure 3).

284

285 FIGURE 3

286

#### 287 4.2 Social network analysis

288 The interviewees acknowledged only a limited set of actors as HCWM stakeholders, and some were  
289 nominated just once. Thus they probably had a very marginal role, confirming the stakeholder analysis  
290 results. Indeed, the Ministry of Transport was nominated by a stakeholder that had never met any of its  
291 representatives. The interactions were concentrated with the MSW service providers, the MoH, and the  
292 MoH' HCFs. However, the MoH's HCFs stated that they had very infrequent contacts, while for other  
293 interviewees they were much more regular (Figure 4). Indeed, MoH's HCFs not only considered some  
294 interactions to be solely informal, they also perceived their contacts with stakeholders about HCWM to be  
295 limited. In general, this difference of perception was valid also for other stakeholders, such as the UNRWA,  
296 EQA, health NGOs, WHO, and private contractors. Only the MoH, the MSW service providers and the health  
297 NGOs noted that they had some internal interactions about the topic (e.g. between different MoH  
298 Directorates, municipalities, or NGOs). While for example neither MoH' HCFs, nor private and NGO' HCFs  
299 had any significant interactions.

300

301 FIGURE 4

302

303 Information circulated quite poorly between stakeholders, and only a few (e.g. the MoH and the WHO),  
304 noted that they had several reliable sources about both the theoretical aspects, as well as the existing  
305 situation in the Gaza Strip. Municipalities had a good picture of what was taking place, but required a  
306 theoretical understanding. On the contrary, HCFs had limited knowledge and information about the issue,  
307 and did not communicate with others, even those in the same category (e.g. the MoH, private hospitals,  
308 NGOs and the UNRWA). Moreover, they largely relied on the internet and any training for information  
309 (Figure 5).

310

311 FIGURE 5

312

313 Indeed, HCFs argued that they possessed only limited information, and needed much more. Only the public  
314 authorities shared a satisfactorily high level of information. The other stakeholders wished to increase the  
315 information circulated, although it was not as pressing a need as for HCFs (Figure 6).

316

317 FIGURE 6

318

319 Stakeholders had different points of view about HCWM, thus they declared different priorities as well.  
320 However, the top three priorities noted were “waste segregation”, “material for first storage and cleaning”,  
321 and “on-site storage”, respectively. This order was confirmed by considering only the first priority declared,  
322 and in particular an intervention directly “within the ward” was required. This opinion was shared by both  
323 health providers and HCFs, while other actors would have liked to first tackle other factors, such as  
324 appropriate disposal of residues (Figure 7).

325

326 FIGURE 7

327

## 328 5. DISCUSSION

### 329 5.1 About the case study

330 The system of HCWM in the Gaza Strip was complicated, with generally limited knowledge and sharing of  
331 information amongst the various stakeholders. All the challenges identified evidently affected several  
332 aspects of HCWM, but the stakeholders declared that financial constraints was the key limiting factor. Even  
333 though the Ministry of Health was highlighted as a key player and various other organizations were also  
334 mentioned, none had significant power, thus theoretically their capacity to effectively affect the system  
335 was limited. Nevertheless, several actors thought that something could be done. Despite the shortage of  
336 material resources, they could use human resources, and introduce best practice and a better organization

337 as a means of improving the system. Such a positive approach was possible, probably due to the time spent  
338 discussing about HCWM during the interviews. Despite the generally limited knowledge, sharing of  
339 information and influence, many, HCF in particular, expressed an interest in HCWM. The level of interest  
340 was generally high, but the lack of a proper discussion platform inhibited any potential action. During the  
341 interviews a global picture of a HCWM system was shared, and HCFs' representatives felt finally involved,  
342 with a better understanding of their role, and the importance of their activity. Indeed they felt that they  
343 now had the ability to positively influence the system. Thus similarly to previous studies, these findings  
344 demonstrate the importance of building knowledge and awareness (Carlsson and Berkes, 2005; Armitage *et*  
345 *al.*, 2009; Bodin and Crona, 2009), as well as motivation (Kilgore *et al.*, 2007; Larsen *et al.*, 2011; Meadows  
346 *et al.*, 2014), to enhance stakeholder networks. Indeed, it looks even more important in the absence of the  
347 driver for improvement constituted by the local legislation (Wilson, 2007).

348

349 Attitudes towards the intervention proposed were very positive, but the knowledge about both the existing  
350 situation and theoretical aspects of HCWM were limited (Sarsour *et al.*, 2014). Interest and knowledge  
351 were evidently linked (Figure 2), as well as attitudes and theoretical knowledge (Figure 3). In addition, the  
352 interest for the proposed project also appeared to be related, however, this may have simply be that the  
353 proposal was well-defined and meeting the stakeholders' needs. The limited communication between  
354 stakeholders was evident, and particularly perceived by HCFs (Figure 6). Only public authorities (e.g.  
355 municipalities and MoH), and the most powerful and informed stakeholders were satisfied with the existing  
356 circulation of information, while all the others felt that it could be improved. However, the absence of any  
357 actor with a high theoretical knowledge (Figure 3) suggested the lack of any local expertise about HCWM.  
358 The socio-political situation had an impact on the functioning of the system. Indeed, technical capacity was  
359 lacking in the Gaza Strip. Thus if the system and the capacity, expertise and knowledge of the networks are  
360 to improve, external support from international experts and organizations is required. In addition, the need  
361 for more information sharing is evident. Interactions were quite polarised between only a few  
362 stakeholders. However, the stakeholders each had different perceptions. For example, HCFs felt quite

363 isolated, despite being nominated by several others (Figure 4). In particular technical staff from different  
364 HCFs, especially in public facilities, did not feel free to officially share their knowledge and experiences.  
365 WHO had an interesting 'hub' position, which could be used to share information, facilitate the  
366 establishment of collaborations between stakeholders, and build the capacity and resilience of the  
367 networks. For example, an official technical platform, facilitated by the WHO, could identify the challenges,  
368 and appoint a task force to develop solutions. In such a way, stakeholders would have regular and official  
369 opportunities to meet and cooperate.

370 The difference between stakeholders' perception was suggested also by the information network (Figure  
371 5). Not all the interactions identified were considered sources of information, but some new sources (e.g.  
372 the internet) were noted. This finding confirms the lack of a reliable local source of information. This is an  
373 issue that needs to be addressed, maybe with the support of a reliable and trusted stakeholder such as the  
374 WHO. Finally, the sources of information were quite specific, dealing only with either theoretical  
375 information or updates about the existing geo-political situation in the Gaza Strip. The information network  
376 was almost composed of two different networks, with just three ties in common. Only three stakeholders  
377 (i.e. WHO, the MoH, and private contractors) gave and received information in both these networks. Thus  
378 these three agencies could be important link points to improve knowledge circulation, using the  
379 interactions and sources of information already in place. Indeed the adaptation best practice could suggest  
380 fit for purpose local solutions, and indicate an appropriate way forward. HCF personnel, and in particular  
381 technical staff, are the most suitable actors, due to the fact that they deal daily with HCW. However, they  
382 evidently need technical and institutional support, in order to improve their capacity and competencies.

383 Identification of priorities reflected the stakeholders' knowledge and work. Actors mainly focused attention  
384 on what they knew, thus they highlighted the risks they perceived the most during their activities (Figure 7).  
385 It was particularly evident for health providers, who focused their attention on HCWM within HCFs, while  
386 public authorities tried to consider also waste production and treatment. Finally, other stakeholders, not  
387 directly involved and with a limited knowledge about practical aspects of HCWM, had difficulty in  
388 identifying priorities. Thus the focus and effectiveness of the network for sustainable management of waste

389 and resources are evidently heavily dependent on understanding the perceptions and expectations of  
390 stakeholders, as this plays a significant role in the effective implementation of an ecosystem-based  
391 approach (Gelcich *et al.*, 2005; Pomeroy and Douvère, 2008).

392

## 393 5.2 About the methodology

394 The initial list of stakeholders was carefully developed based on the available information, thus the  
395 snowball method was required to identify just a few other important actors (Costa and da Cunha 2010).

396 The benefit of utilizing such an approach is also supported by the social network diagrams of both  
397 interaction and information sharing. No new primary stakeholders were identified, considering both the  
398 ties and their strength (Henriksen *et al.*, 2007). The identification of such networks and their challenges can  
399 be employed to suggest which resources and actions are required (Carlsson and Berkes, 2005; Newman and  
400 Dale, 2007), in order to improve the sustainability of environment management (Kilgore *et al.*, 2007; Larsen  
401 *et al.*, 2011; Meadows *et al.*, 2014).

402

403 The methodology proposed was appropriate to put a deliberative approach in practice (Levänen and  
404 Hukkinen, 2013). The case study showed that the integration of stakeholder analysis and social network  
405 analysis is possible in practice not only in high-income countries (Reed *et al.*, 2009; Lienert *et al.*, 2013), but  
406 also in complex settings like the Gaza Strip. It also demonstrated that the methodology proposed in Caniato  
407 *et al.* (2014) could be improved. The topics in Table 1 were modified to make them clearer; questions were  
408 revised to ensure a smoother flow during interviews, and better adaptability to the local context;  
409 interviewees gave score on a 1-5 scale and drew their own networks, reducing the need for data recoding  
410 and processing; and evaluation of priorities was introduced, thus interviewees could give their opinion  
411 about the future of the HCWM system in a quick and easy way.

412

## 413 6. CONCLUSIONS



414 Using stakeholder and social network analyses, this study has examined the manner in which a range of  
415 socio-economic (e.g. perceptions and access to finance) and logistical (e.g. information sharing and  
416 interactions) factors impacted upon the effectiveness of stakeholder networks involved in the management  
417 of health-care waste in the Gaza Strip. The interaction of these factors was found to be complicated and  
418 significantly impacted upon the effective functioning of the system, particularly given the constraints of the  
419 geo-political situation in the case study region. Despite these complications and limitations, potential  
420 options for improvement were identified. These options included capacity building of local stakeholders,  
421 improving the sharing of information and using ‘hubs’ comprised of local and external support. It is only  
422 through such a holistic and deliberative approach that a more resilient system can be developed and  
423 sustained. This is particularly crucial given not only the environmental benefits to be accrued from a more  
424 sustainable approach to managing healthcare-waste, but also the wider socio-economic and public health  
425 benefits. Indeed, more effective management would lead to reduced risks to the population, thereby  
426 improving public health and enabling targeting of financial resources. In addition, better sharing of  
427 information about waste management should also lead to co-operation on other issues amongst key public  
428 and private sector agencies in the country, as well as between these organizations and the community, and  
429 the organizations and international agencies. Finally, the findings should also serve to contribute to the  
430 literature on the management of resources and stakeholder networks in countries facing similar issues.

431

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439

440 REFERENCES

- 441 Adam, S., Kriesi, H. 2007. The network approach. In: Sabatier, P. (ed.). The theories of the policy  
442 process. Westview Press. Boulder. Co. 129-154.
- 443 Alameddine, M., Naja, F., Abdel-Salam, S., Maalouf, S., Matta, C. 2011. Stakeholders' Perspectives  
444 on the Regulation and Integration of Complementary and Alternative Medicine Products in  
445 Lebanon: A Qualitative Study. BMC Complementary and Alternative Medicine 11, 71.
- 446 Al-Khatib, I.A., Al-Qaroot, Y.S., Ali-Shtayeh, M.S. 2009. Management of healthcare waste in  
447 circumstances of limited resources: a case study in the hospital of Nablus city, Palestine.  
448 Waste Management & Research 27 (4), 305-312.
- 449 Armitage, D.R., Plummer, R., Berkes, F., Arthur, R.I., Charles, A.T., Davidson-Hunt, I.J., Diduck, A.P.,  
450 Doubleday, N.C., Johnson, D.S., Marschke, M., McConney, P., Pinkerton, E.W., Wollenberg,  
451 E.K. 2009. Adaptive co-management for social–ecological complexity. Frontiers in Ecology and  
452 the Environment 7 (2), 95-102.
- 453 Baber, W.F., Bartlett, R.V. 2005. Deliberative environmental politics: democracy and ecological  
454 rationality. MIT Press. Cambridge.
- 455 Bodin, Ö., Crona, B.I. 2009. The role of social networks in natural resource governance: what  
456 relationship patterns make a difference? Global Environmental Change 19 (3), 366-374.
- 457 Borgatti, S.P., M.G. Everett, and L.C. Freeman. 2002. Ucinet for Windows: Software for Social  
458 Network Analysis. Harvard, USA: MA: Analytic Technologies. <http://www.analytictech.com/>.

459 Caniato, M., Vaccari, M. 2014. How to assess Solid Waste Management in armed conflicts? A new  
460 methodology applied to the Gaza Strip, Palestine. *Waste Management & Research* published  
461 online on 8 August 2014, DOI: 10.1177/0734242X14543553.

462 Caniato, M., Vaccari, M., Visvanathan, C., Zurbrügg, C. 2014. Using Social Network and Stakeholder  
463 Analysis to Help Evaluate Infectious Waste Management: A Step towards a Holistic  
464 Assessment. *Waste Management* 34 (5), 938-951.

465 Cárcamo, P.F., Garay-Flühmann, R., Gaymer, C.F. 2013. Opportunities and constraints of the  
466 institutional framework for the implementation of an ecosystem-based management: the  
467 case of the Chilean coast. *Ocean and Coast Management* 84, 193-203.

468 Cárcamo, P.F., Garay-Flühmann, R., Sueo, F.A., Gaymer, C.F. 2014. Using stakeholders' perspective  
469 of ecosystem services and biodiversity features to plan a marine protected area.  
470 *Environmental Science and Policy*. In Press.

471 Carlsson, L., Berkes, F. 2005. Co-management: concepts and methodological implications. *Journal*  
472 *of Environmental Management* 75 (1), 65-76.

473 Carollo, C., Reed, D.J. 2010. Ecosystem-based management institutional design: balance between  
474 federal, state, and local governments within the Gulf of Mexico Alliance. *Marine Policy* 34 (1),  
475 178-181.

476 Chambers, S. 2003. Deliberative democratic theory. *Annual Review of Political Science* 6, 307-326.

477 Costa, C.C., Da Cunha, P.R. 2010. Who Are the Players? Finding and Characterizing Stakeholders in  
478 Social Networks. *Proceedings of the Annual Hawaii International Conference on System*  
479 *Sciences* 5428684.

480 Crona, B., Bodin, Ö. 2006. What you know is who you know? Communication patterns among  
481 resource users as a prerequisite for co-management. *Ecological and Society* 11 (2), 7.

482 Dietz, T., Ostrom, E., Stern, P.C. 2003. The struggle to govern the commons. *Science* 302 (5652),  
483 1907-1912

484 de Titto, E., Savino, A., Townend, W.K. Healthcare waste management: the current issues in  
485 developing countries. *Waste Management & Research* 30 (6), 559-561.

486 Dryzek, J. 2010. Foundations and frontiers of deliberative governance. Oxford University Press. NY.

487 Folke, C., Pritchard, L., Berkes, F., Colding, J., Svedin, U. 2007. The problem of fit between  
488 ecosystems and institutions: ten years later. *Ecology and Society* 12 (1), 30.

489 Friend, J., Hinckley, A. 2005. Planning under pressure. The strategic choice approach. Taylor &  
490 Francis. Amsterdam.

491 Gelcich, S., Edwards-Jones, G., Kaiser, M.J. 2005. Importance of attitudinal differences among  
492 artisanal fishers toward co-management and conservation of marine resources. *Conservation*  
493 *Biology* 19 (3), 865-875.

494 Google Earth 7.1.2.2041. 2013. The Gaza Strip 31°23'55.83"N, 34°44'37.76"E, eye alt. 69.44 km,  
495 SIO, NOAA, U.S. Navy, NGA, GEBCO. U.S. Dept. of State Geographer. CNES/Astrium 2014,  
496 DigitaGlobe 2014. <http://www.google.com>. Accessed on 26/6/2014.

497 Grimble, R., Wellard, K. 1997. Stakeholder methodologies in natural resource management: a  
498 review of principles, contexts, experiences and opportunities. *Agricultural Systems* 55 (2),  
499 173-193.

500 Guntman A., Thompson, D. 2004. Why deliberative democracy? Princeton University Press.  
501 Princeton.

502 Hagedorn, K. 2008. Particular requirements for institutional analysis in nature related sectors.  
503 European Review of Agricultural Economics 35 (3), 357-384.

504 Hajer, M., Wagenaar, H. 2003. In: Hajer, M., Wagenaar, H. (eds.). Deliberative policy analysis:  
505 understanding governance in the network society. Cambridge University Press. Cambridge. 1-  
506 30.

507 Heck, N., Dearden, P. 2012. Local expectations for future marine protected area performance: a  
508 case study of the proposed national marine conservation area in the Southern Strait of  
509 Georgia, Canada. Coastal Management 40 (6), 577-593.

510 Henriksen, H.J., Rasmussen, P., Brandt, G., Bulow, Dv., Jensen, F.V. 2007. Public participation  
511 modelling using Bayesian networks in management of groundwater contamination.  
512 Environmental Modelling and Software 22 (8), 1101-1113.

513 Kenis, P., Scheider, V. (1991). Policy networks and policy analysis: scrutinizing a new analytical  
514 toolkit. In: Marin, B., Mayntz, R. (eds.). Policy networks: empirical evidence and theoretical  
515 considerations. Westview Press. Boulder, Co. 25-59.

516 Kidd, S., Plater, A., Frid, C. 2011. The ecosystem approach to marine planning and management  
517 Earthscan. Washington, D.C.

518 Kilgore, M, Greene, L., Jacobson, M., Straka, T., Daniels, S. 2007. The influence of financial  
519 incentive programs in promoting sustainable forestry on the nation's family forests. Journal of  
520 Forestry 105 (4), 184-191.

- 521 Jensen, F. 2002. Bayesian networks and decision graphs. *Statistics for Engineering and Information*  
522 *Science*. Springer. New York.
- 523 Larsen, S., Foulkes, M., Sorenson, C., Thimpson, A. 2011. Environmental learning and the social  
524 construction of an exurban landscape in Fremont County, Colorado. *Geoforum*. 42 (1), 83-93.
- 525 Lennartsson, M., Kvarnström, E., Lundberg, T., Buenfil, J., Sawyer, R. 2009. Comparing sanitation  
526 systems using sustainability criteria. SEI, Stockholm. Sweden.
- 527 Levänen, J.O., Hukkinen, J.I. 2013. A methodology for facilitating the feedback between mental  
528 models and institutional change in industrial ecosystem governance: a waste management  
529 case-study from northern Finland. *Ecological Economics* 87, 15-23.
- 530 Lienert, J., Schnetzer, F., Ingold, K. 2013. Stakeholder analysis combined with social network  
531 analysis provides fine-grained insights into water infrastructure planning process. *Journal of*  
532 *Environmental Management* 125, 134-148.
- 533 Long, J.C., Cunningham F.C., Wiley J., Carswell P., Braithwaite J. 2013. Leadership in Complex  
534 Networks: The Importance of Network Position and Strategic Action in a Translational Cancer  
535 Research Network. *Implementation Science* 8 (1), 122.
- 536 Lopes, P.F.M., Rosa, E.M., Salyvonchyk, S., Nora, V., Begossi, A. 2013. Suggestions for fixing top-  
537 down coastal fisheries management through participatory approaches. *Marine Policy* 40(1),  
538 100-110.
- 539 Lundie, S., Peters, G., Ashbolt, N., Lai, E., Livingston, D. 2006. A sustainability framework for the  
540 Australian water industry. *Water* 33 (7), 83-88.

541 Lüthi, C., Morel, A., Tilley, E., Ulrich, L. 2011. Community-led Urban Environmental Sanitation  
542 Planning. EAWAG/SANDEC, Duebendorf.

543 MacLean, S., Burgess, M. 2010. In the public interest: assessing expert and stakeholder influence in  
544 public deliberation about biobanks. *Public Understanding of Science*, 19, 486-496.

545 Marias, D.C., de Almeida, A.T. 2007. Group decision-making for leakage management strategy of  
546 water network. *Resources, Conservation and Recycling* 52 (2), 441-459.

547 McLeod, K.L., Leslie, H.M. 2009. *Ecosystem-based management for the oceans*. Island Press,  
548 Washington, DC.

549 Meadows, J., Herbohn, J., Emtage, N. 2014. Engaging Australian small-scale landowners in natural  
550 resource management programmes - perceptions, past experiences and policy implications.  
551 *Land Use Policy* 36, 618-627.

552 Mendenhall, M.A. 2014. Educational sustainability in the relief-development transition: challenges  
553 for international organizations working in countries affected by conflict. *International Journal*  
554 *of Educational Development* 35, 67-77.

555 Newman, L., Dale, A. 2007. Homophily and agency: creating effective sustainable development  
556 networks. *Environment, Development and Sustainability* 9 (1), 79-90.

557 OPt Health and Nutrition Cluster 2012. CAP 2012-13 Needs Analysis Framework. Available at  
558 [http://www.emro.who.int/images/stories/palestine/documents/Health.Nutrition\\_Cluster.needs\\_analysis\\_framework.pdf?ua=1](http://www.emro.who.int/images/stories/palestine/documents/Health.Nutrition_Cluster.needs_analysis_framework.pdf?ua=1). Accessed on 20/4/2014.

560 PCBS (Palestinian Central Bureau of Statistics) 2013. Population of Palestine. Available at  
561 [www.pcbs.gov.ps/site/881/default.aspx#PopulationA](http://www.pcbs.gov.ps/site/881/default.aspx#PopulationA). Accessed on 14/4/2014.

562 Phillips, P.S., Tudor, T.L., Bird, H., Bates, M.B. 2011. A critical review of a key Waste Strategy  
563 initiative in England: Zero Waste Places Projects 2008-2009. *Resources, Conservation and*  
564 *Recycling* 55 (3), 335-343.

565 Pomeroy, R., Douvère, F. 2008. The engagement of stakeholders in the marine spatial planning  
566 process. *Marine Policy* 32 (5), 816-822.

567 Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H.,  
568 Stringer, L.C. 2009. Who's in and why? A typology of stakeholder analysis methods for natural  
569 resource management. *Journal of Environmental Management* 90 (5), 1933-1949.

570 Roy, B. 2010. Two conceptions of decision aiding. *International Journal of Multicriteria Decision*  
571 *Making* 1 (1), 74-79.

572 Rushbrook, P., Zghondi, R. Better Health Care Waste Management: an integral component of  
573 health investment. World Health Organization, Amman:  
574 [http://www.who.int/water\\_sanitation\\_health/medicalwaste/bhcmeng.pdf](http://www.who.int/water_sanitation_health/medicalwaste/bhcmeng.pdf). Accessed on  
575 22/06/2014.

576 Salem, R. 2013. Gaza's challenge. *Chartered Institution of Wastes Management (CIWM) Journal*  
577 April. 48-49.

578 Sarsour, A., Ayoub, A., Lubbad, I., Omran, A., Shahrour, I. 2014. Assessment of Medical Waste  
579 Management within Selected Hospitals in Gaza Strip Palestine: A Pilot Project. *International*  
580 *Journal of Scientific Research in Environmental Sciences* 2 (5), 164-173.



581 Schmeer, Kammi. 1999. Guidelines for Conducting a Stakeholder Analysis. Bethesda, USA:  
582 Partnerships for Health Reform, Abt Associates Inc.  
583 <http://www.who.int/management/partnerships/overall/GuidelinesConductingStakeholderAn>  
584 [alysis.pdf](http://www.who.int/management/partnerships/overall/GuidelinesConductingStakeholderAnalysis.pdf). Accessed on 14/4/2014.

585 Scholz, J.T., Wang, C.-L. 2006. Cooptation or transformation? Local policy networks and federal  
586 regulatory enforcement. *American Journal of Political Science* 50 (1), 81-97.

587 Simon, U., Brüggemann, R., Pudenz, S. 2004. Aspects of decision support in water management  
588 example Berlin and Potsdam (Germany) II-improvement of management strategies. *Water*  
589 *Research* 38 (19), 4085-4092.

590 Starkl, M., Brunner, N., López, E., Martínez-Ruiz, J.L. 2013. A planning-oriented sustainability  
591 assessment framework for peri-urban water management in developing countries. *Water*  
592 *Research* 47 (20), 7175-7183.

593 Stern, N. 2006. The Stern review on the economics of climate change. HMSO. London. UK

594 Tudor, TL., Woolridge, AC., Phillips, CA., Holliday, M., Laird, K., Bannister, S., Edgar, J., Rushbrook,  
595 P. 2010. Evaluating the link between the management of clinical waste in the National Health  
596 Service (NHS) and the risk of the spread of infections: a case study of three hospitals in  
597 England. *International Journal of Hygiene and Environmental Health* 213 (6), 432 - 436

598 UNDP. 2012. Feasibility study and detailed design for solid waste management in the Gaza Strip.  
599 Palestine: Gaza. (unpublished).

600 UNOPT. 2012. Gaza in 2020, a liveable place? Available at  
601 <http://www.unrwa.org/userfiles/file/publications/gaza/Gaza%20in%202020.pdf>. Accessed on  
602 14/4/2014.

603 Walters, C., Holling, C.S. 1990. Large scale management experiments and learning by doing.  
604 *Ecology* 71 (6), 2060-2068.

605 Weber, T.C., Allen, W.L. 2010. Beyond on-site mitigation: An integrated multiscale approach to  
606 environmental mitigation and stewardship for transportation projects. *Landscape and Urban*  
607 *Planning* 96 (4), 240-256.

608 WHO (World Health Organization). 2011. Health-care waste management. Fact sheet N<sup>o</sup>281.  
609 Available at: <http://www.who.int/mediacentre/factsheets/fs281/en/>. Accessed on 15/9/2014

610 Wilson, D.C., 2007. Development drivers for waste management. *Waste Management and*  
611 *Resource* 25 (3), 198-207.

612