Supplementary Material

Role of citizen scientists in environmental plastic litter research – a systematic review

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Table SM1: Studies involving plastic waste/litter and citizen science.

Reference	Type of study	Location	Duration	No. or participants	Types of participants	Types of waste discussed	Details
[1]	Questionnaires	USA		306	Volunteers in citizen science environmental programs	Attitudes and behaviour towards the environment and litter	Open-ended, 5-point Likert-type multiple choice questions
[2]	Questionnaires	China	1 month	7,427	General citizens	Waste separation	
[3]	Questionnaires & interviews applied by school children	Chile, coastal area		909	School children (age ~ 12) as interviewers; local community	Beach litter	
[4]	Interviews	Estonia, Germany, Sweden, Greece,		50	Stakeholders and experts (governmental, non-governmental,	Marine litter management	Semi-structured interviews

		Italy, Tunisia			research, industry and business)		
[5]	Questionnaires	Iran, Amol		200	Random citizens	Waste management system	
[6]	Questionnaires &interviews	India, Delhi		800	Households	Composting and segregation	
[7]	Questionnaires & interviews	Ghana, Delhi	April 2017	157	Household owners	Waste management & health related risks associated with anthropogenic waste	Face-to-face interviews
[8]	Questionnaires	Vietnam, Phou Quoc	2017-2018		Local authorities, tourism experts, environmental experts, tourists, residents	General waste	Semi-structured, open interviews; participatory observation; off-the-record conversations; visual documentation
[9]	Interviews On attitude towards litter and recycling	Chile	2012-2016		Locals	General litter	Interviews made by researchers and by schoolchildren
[10]	questionnaire	Germany, USA	August 2018	6726 citizens		Plastic waste	
[11]	Q-method	United Kingdom		22	Stakeholders from government agency, plastic	Marine plastic waste management	

					manufacturer, retailer, research and citizens representatives		
[12]	On site interviews	Zimbabwe, Mutare	July 2016	23 households	Local citizens	Household waste	Interviews and on-site questionnaires
[13]	Online questionnaires &workshop	United Kingdom	2019-2020	22 organizations	Organizations that held clean-ups with volunteers	Anthropogenic litter	
[14]	Interviews	Norway	2017-2018	21	Fishermen	Waste management practices	Semi-structured interviews: telephone or face to face
[15]	Interviews	Finland	2009-2013	> 15 organizations	Companies, ministries & other organizations	Recycling	
[16]	On-line questionnaires	Israel	August-September 2017	159	Beach users & managers	General waste on beach	
[17]	Interviews	USA	16 months	400	Volunteers in beach litter surveys	General waste	Face-to face
[18]	Interviews by telephone or skype	Review of 10 CS projects				macro- and microplastic litter	semistructured
[19]	Questionnaiers	South Africa, Durban		120	Beach goers	Consumer attitudes towards plastic, plastic reuse, plastic	

							waste awareness				
[20]	Post, phone or online survey	USA, San Francisco	May-June 2011	3,979	Citizens		Waste recycling and composting				
[21]	Interviews	Taiwan	2017-2019	32	Private companies & public institutions involved in circular economy		Plastic waste recycling industry				

Reference	**Type of study**	**Location**	**Duration**	**No. or participants**	**Training**	**Types of participants**	**Types of waste discussed**	**Details**	**Questionnaires pre/post study**
[22]	Social media	Philippines	2011-2018	32 posts		Facebook posts	Marine litter & megafauna	Organizations and community pages	No
[23]	Social media	Global		147,552 tweets		Posts on Twitter	Marine plastic pollution	Original tweets	No

Reference	**Type of study**	**Location**	**Duration**	**No. or participants**	**Training QA/QC**	**Types of waste analysed**	**Details**	**Average density**	**Dominant waste**	**questionnaires pre/post study**
[24]	Coastline litter survey	The Bahamas, South Eleuthera	6 months, 2013	417		Plastic, metal, rubber, paper & processed lumber, glass, cloth and fabric)	Anthropogenic waste; Items > 2.5 cm		Plastic (93%)	No

[25]	Water samples	USA, Gallatin River watershed (74 sites)	2 years (seasonally)	117	1 day field training on data collection; self-assessment sheet; photos of clothes during sampling; 10 random samples were measured in the lab	Microplastics	Items < 10 mm	1.2 particles / L	Microplastics – found in 57 % samples; 80 % of microplastics were fibres	Self-assessment questionnaire
[26]	Coral reef survey	Australia, Queensland	5 months/ year 2001-2016	622 surveys	Data recording Photographs	Fishing line, fishing net, general rubbish			Fishing line (9-72%) & Fishing net (7-8%) ; Plastic - 32 % of the general rubbish	No
[27]	Coastline survey	Norway, Svalbard Archipelago	2016 (6 tourist cruises)		Photograph of biota interacting with litter; survey via online calls.	Plastic, fisheries-related plastic, clothing, metal, glass, biotic	Visible litter	9-524 g/m^2	Fisheries-related plastic; other plastic items (packaging material, bottles, cups, spoons, tooth brushes, toys)	No

[28]	Coastline sampling	Global	Summer 2015		Online sampling protocol; 5 sample replicates; samples sent to lab	Microplastics	< 5 mm			No
[29]	Coastline survey	Australia	2016-2018	-	Plastic fragments and particles sent to lab	Divided based on land-use category	Items > 1 mm-5 mm		Polyethylene (53.71%) and polypropylene (35.17%)	No
[30]	Coastline survey	China, 18 coastal cities	2018, one day every two months	(28 teams)	Sampling and investigation methods	Domestic, recreation and fishing/aquaculture	Items ≥ 2.5 cm, weight	3.85 ± 5.39 items / m^2	Plastic waste (78%)	No
[31]	Floating marine litter	Taiwan	2017-2018	40 volunteers	Survey protocol; Photographs, videos	Plastic, fishery tools, polystyrene foam, other	Floating litter	90.10 ± 8.60 items/km^2	Plastic (63.2%): bottles (31.6%), bags and packaging (28%), other plastic (27%)	Yes, interviews pre-survey
[32]	Sea survey	Croatia, Cyprus, France, Gibraltar, Greece,	2011-2018	SCUBA divers	Sampling protocol; Marine debris identification guide	Plastics / polymer, glass / ceramics, metal, rubber, wood	Submerged macro waste	43.55/100 m^2 (±4.50)	Plastics /polymers (54.50 %); plastic fragments	No

		Israel, Italy, Malta, Montenegro, Slovenia, Spain, Tunisia, Turkey (172 locations)				processed, natural textiles/fibres. Paper and cardboard, other			(9.46 %), plastic bottles (6.33%). Single use plastic items 32.94 % of total marine litter.	
[33]	Coastline litter survey	Australia	2018-2021	Beach goers	Not mentioned	Plastic and other litter	Anthropogenic litter; >5 mm	0.056 pieces/m^2	Plastic (87 %)	No
[34]	Coastline and river surveys	Mexico to Chile	2018-2019	School children (age 10-18) from 33 schools	Educational material; protocol; past similar projects; Photographs of maps, drawings and items collected from beach sent to researcher; random drawings and maps crosschecked by researchers	Drawings and hand-made maps of the environment; objects collected from the beach	General litter		Plastic (61 %)	No
[35]	Coastline litter survey	Chile		School children <18 years	Educational materials; instructions; sampling kits	Samples recounted by researchers	Microplastics			Yes, interviews with beach goers

					Supervised by teachers and university graduates					Interviews with schoolchildren
[36]	Water samples	Russia, White Sea basin	Summer-autumn 2020	200	Sampling training; video tutorials; online manuals Laboratory analyses; trained volunteers supervised by experts	Microplastics		1.14 particles / m^3	PE, PET and PVC	No
[37]	Coastline survey	Norway	2010-2016	3 studies	Standard protocol; comparison to professional data	Anthropogenic litter; 13 categories			Plastic (75-99 %)	No
[38]	Roadside survey	Canada, from Montreal-Quebec	10 days, September 2021	-	Not mentioned	Face masks	-	0.0001 ± 0.00006 face masks / m^2	76% disposable surgical masks	No
[39]	Watershed survey	Canada, Ottawa River		17 groups of citizens	Sample collection and filtration; Laboratory measurements	Microplastics		0.11 microplastics / L (SD 0.09)	98 % microfibres	No
[40]	Image classification (satellite, orthophotos, geo-tagged	Global	2014-2020	> 4,500 volunteers	Online guidelines	Several environmental and social indicators, including marine plastic litter		101 images with marine litter out of 1,215 images		No

	photographs, drone imagery etc)									
[41]	Aquatic life interacting with litter	Global	2003-2021	113 photographers	No training; Underwater images from dedicated databases, Facebook and Instagram Users and photographers were contacted by researchers for comments	Benthic octopuses interacting with general litter			24.7 % was plastic	No
[42]	Coastline survey	Australia	2009 - 2019	2,418		133 categories	> 5 mm		Plastic (84%)	No
[43]	Mangrove clean-up	Columbia, Providencia & Santa Catalina islands	2020-2021	71 community volunteers	Professional research in parallel; volunteers supervised by trained community leaders	Plastic, metal, glass, paper/cardboard, processed wood, rubble, textile	Large items	0.4 – 1.4 items/m^2	Plastic (60%)	Yes, Semi-structure interviews
[44]	Coastline litter clean-up	Norway	2011-2018	Not mentioned (445 clean-up actions)		Commercial, private, household, other			Rope (16%), plastic beverage bottles (13%), Styrofoam	No

									(11%), lids and caps (9%).	
[45]	Coastline litter clean-up and survey	Canada	2007-2017	2 different programs with >5500 records combined		Plastic litter				No
[46]	Coastline litter survey	Chile and Germany	May – June 2016	> 30 teachers; > 600 schoolchildren	Theory about marine litter; protocol Local advisors supported the participants; standardized methodology	Papers, cigarette butts, plastics, metal, glass, processed wood, natural wood, algae, lants and other residues	> 25 mm	2.2 items/m^2 in Chile 0.4 items/m^2 in Germany	Plastic (24.1 % - 84.9 %)	No
[47]	Riverine litter survey	Chile	2013-2017	700 schoolchildren (age 10-18); 35 teachers	Protocol, scientific questions, hypotheses Supervised by teachers, who were coordinated by researchers	Papers, cigarette butts, plastics, metals, glass, other items	> 25 mm	Riverside: 0.01-6.8 items/m^2 Floating: 10.1 ± 13.5 items/h	Riverside plastic (29%) Floating plastic (58% in 2013-75% in 2017)	No
[48]	Coastline survey	Chile	October - November 2011	983 schoolchildren (8-16 years old)	Sampling protocol Researchers re-evaluated the samples	Small plastic debris		27 small plastic pieces / m^2		Yes, post-survey regarding the activity and plastic litter

[49]	Riverside litter	Germany	2016-2017	>5500 schoolchildren	Sampling protocol Photographs, Predefined protocol	Paper, cigarettes, plastic, metal, glass, food leftovers, other items	Anthropogenic litter	0.54±1.2 items/m²	Plastics dominant (30.5%)	No
[50]	River litter	Germany	2016-2017	5500 schoolchildren	Sampling protocol Samples sent to laboratory; photographs	General litter Meso- & microplastics	> 25 mm	Floating macrolitter 0-8.25 items/mh Floating meso-/microplastics 0-220 particles/h	Plastic (68%)	No
[51]	Coastal survey	Vietnam	2007-2014			Plastic pellets		80-100 pellets / beach		No
[52]	water samples and shoreline survey	Canada, Island of Montreal	2013-2015	69 participants	Sample collection and measurements Simultaneous samples were sent to lab for validation	Shoreline and recreational activities; fishing activities; smoking-related activities; dumping; medical/personal hygiene; other debris of local concern		< 20 items / 360 m²		no

[53]	Fish GI tracts	Canada	2015	Locals and commercial fisheries	Protocol on collecting and sending the samples Samples measured in the lab		Microplastics; < 5mm	Ingestion prevalence 2.3%		No
[54]	Students perception; Coastline survey	Italy	April 2018	194 students (16-17 years old)	Marine litter categories and cataloguing methods Guidelines and protocols; researchers accompanied the students	34 categories	Macro-litter: items ≥ 2.5 cm; microplastic	-	-	Pre- and post-survey questionnaires
[55]	Coastline clean-up	Cyprus	2016-2017	214	Hands-on training; Sampling protocol and data sheets Standardized protocol	5 main categories based on use	General waste		Single-use plastics among the most frequent litter items	No
[56]	Street litter	Global	2017-onwards		Guided app, OpenLitterMap Data manually checked by a team of trained volunteers	Over 100 categories by type and brand	Anthropogenic waste			No
[57]	Sediment samples along the coastline	United Kingdom	June-August 2018		Sampling protocol Samples measured in the lab; blank samples;	Microplastics		From 357.1 particles / kg sediment	Fragments (93%)	No

					Photographs of the area; Protocols sampling			to 7,393 particles / kg sediment		
[58]	Beach litter survey	United Kingdom	2005-2014	736 beach clean-ups	Best practice instructions; litter identification guides; face-to-face training Validation by survey coordinator	Plastic, polystyrene, rubber, cloth, metal, medical, sanitary, faeces, paper, wood, glass, pottery / ceramic	Anthropogenic litter	o.oo85 items /m/min/pers	Plastic (66%) Large plastic fragments (13%) small plastic items (10%)	No
[59]	Beach litter clean-up	England	1994-2018	Not mentioned; 2378 beach clean-ups		7 categories by source (non-sources, public litter, fishing, sewage, shipping, fly-tipped and medical) 11 categories by material & types of plastic waste	Anthropogenic litter		Plastic (68.4 %)	No
[60]	Coastline survey	Vietnam	September 2020-January 2021	6-10 volunteers/survey; 14 surveys	Survey method; accompanied by experienced team members	10 litter types	Anthropogenic litter (> 2.5 cm)	4.63 ± 5.26 items/m^2	Plastic (fishing gear 17.65% & soft	No

									fragments 17.24%)	
[61]	Households waste management	Kingdom of Eswatini, Zikhotheni & Zombodze Emuva	December 2018-January 2019		Measurement protocol	7 types of plastic	Plastic waste	15.9 g/day of plastic waste	LDPE (92.6 % of households)	Yes, questionnaires on plastic waste management (close and open-ended questions)
[62]	Plastic litter clean-up and lab analysis	Denmark, 98 municipalities	2 days	> 57,000 school children (age 7-16)	Educational materials, Specific protocol, Teacher supervision					Yes, online 931 pre-surveys 838 post-survey
[63]	Marine litter	Israel	2015-2018	Volunteer divers	4 days training course	Fishing & boating, domestic, recreational, construction & industrial	Anthropogenic litter	11.4 items/400 m^2	Plastic predominant and increasing every year	No
[64]	Water samples analysis & Coastline clean-up	Canada, USA, the Great lakes	1 day	> 1,000	Samples also collected by scientists; samples analysed on vessels and some sent to a laboratory	Microplastic Plastic shoreline litter				Yes, questionnaire prior to campaign
[65]	Household waste survey	Argentina, Buenos Aires	March 2019-	1333 citizens	Instructions, remote assistance, protocol	Paper and cardboard; plastic; other	General waste		Plastic (8%)	Yes, pre-experiment

			Februar y 2020			recyclable waste; organic; non-recyclable.				questionnaire
[66]	Riverine litter	Chile		School children (ages 10-15) and teachers	Sampling protocol Comparison volunteers with professionals	Plastics, paper, cigarette stubs, glass, metal, other		0.92 – 5.29 items/m^2; plastics 5.23 items/m^2		No
[67]	Household waste	Peru, Lima	2020	120 citizens	Four online sessions on solid waste management, methodology, composting and organic gardens, preliminary results Constant communication with volunteers through WhatsApp; photographs	Several categories; plastic included in the recyclable categories	Household waste		Plastic (6.59%)	Yes, questionnaires
[68]	Coastline clean-up	Brazil, Santos Bay	2019-2020 (4 campaigns)	480 volunteers from private companies, schools, NGOs, scouts groups	1 h workshop	10 categories			Plastic debris, polystyrene foam and cotton swabs most prevalent	No

									(64.8%-72.5%	
[69]	Coastline survey	Germany, Lithuania	2011-2015	Experts and volunteers	Standard protocols Survey repeated 5-14 times; Birds carcases and nests sent to lab	Plastic, polystyrene; cloth; wood; glass; pottery, ceramics; rubber; paper, cardboard; metal; sanitary waste; other pollutants	General litter, >0.5 cm		Plastic, polystyrene (64-91%); Plastic packaging (57%) and other plastic parts (31%)	Yes
[70]	Coastline survey	Taiwan	April-September 2020	28 volunteers	Three workshops; Volunteers participated before to clean-up events	14 categories	General marine litter	12.7 m^3/km	Plastic bottles (20 %)	Yes
[71]	Drifters on sea and rivers	Germany	2016-2019	>27,000 reports	Short instructions placed near drifters		General waste			No
[72]	Land litter	United Kingdom	2020		Mobile app guidance Photographs, Possibility to scan barcodes for branded wastes	Various categories based on use, material and brand	Anthropogenic litter		Plastic (63.11%)	No
[73]	Land litter	Danish Realm (Denmark, Greenland, Faeroe Islands)	2019	57,000 volunteers	Simple protocol; teaching material	22 categories based on use	Plastic litter	105.4±3.1 pieces of plastic / transect		No

[74]	Coastline survey	USA, Gulf of Mexico	November 2018-August 2019	744 volunteers	Training video Sampling protocol; Photographs; discussions with volunteers; independent site visits	Nurdles		0-30,846/ 10 min of survey	No
[75]	Coastline survey	USA, UK, Norway, Spain, Portugal, France, Belgium, Netherlands, Denmark, Cape Verde	2015-2018	279	Protocol Photographs, 20 cartridges sent to lab		Washed up plastic inkjet cartridges		No
[76]	Coastline survey	Australia		<7,000 school children, teachers and corporate participants	10-day training session on data collection Groups supervised by researchers				No
[77]	Coastline survey	USA, the Great Lakes	2003-2014	2,298	1 day training session on collection methods and data recording Protocols for data recording	Food related, smoking-related, waterway activities, medical/personal hygiene,	> 1 cm for large items	Plastic predominant in small items category	No

						dumping related materials, miscellaneous items, and small (≤ 2.5 cm)				
[78]	Coastline surveys	Croatia, Cyprus, France, Greece, Italy	2 months 2018		Webinar, step-by-step protocol	Single use plastics, non-single use plastics; non-plastic litter		714 items/100 m	Plastic (90%)	No
[79]	Coastline survey and clean-up	Taiwan	2004-2016	541 clean-ups (1-1660 volunteers for each event)	Online instructions Comparison with official data	Plastic, plastic mixed materials, non-plastic	Large items	2730 items/km	90% of the coastal debris was of plastic or plastic mixed materials	No
[80]	Coastline survey	Chile and Germany	April-August 2016	812 school children (age 9-18)	Workbook with instructions and general information on plastic waste and the environment; Trained teachers; 2 groups of schoolchildren: experimental and control	Plastic waste				Yes, environmental psychology ; last open-ended question
[81]	Coastline survey & clean-up	Spain, coastal areas	Since 2013,	(851 surveys)	In situ demonstrations, online training,	Plastic, metal, paper and cardboard,	Items larger than 0.5 cm,	128 items / 100 m	Plastic waste (74%)	No

			each season	intercalibration workshops, photo guide, app, data collection protocol; Contacting the participant for details	sanitary waste, cloth, rubber, glass, pottery, medical waste, faeces, paraffin/wax		(median value)		
[82]	Coastline survey	Taiwan	2018-2019	Two-day workshop	Plastic bottles, single-use plastic, plastic bags, cigarette waste, glass bottles, cans, paper, foamed plastics; fishery buoys, nets and ropes, fishing gear; other items.	Large items		Plastic bottles (30.0%) Foamed plastics (20.8%) Fishing nets and ropes (17.2%)	No
[83]	Coastline survey	Australia New Zealand	2006-2014	Educational programs; accompanied by a researcher; constant communication with volunteers	Persistent organic pollutants in plastic litter	Plastic pellets			Yes (on-site interviews)

QA/QC – quality assurance / quality control

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