Shit-Flow Diagram for Hubli-Dharwad, Karnataka, India

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Project Area Description

The city centers of Hubli and Dharwad are located in north-west Karnataka, 476 km south of Mumbai, and 411 km north of Bangalore. The two cities were founded separately, but due to their proximity (being separated by only 20 kilometers), their municipal governments were combined into one common administration in 1925, and in 1965 this entity gained its current status as the Hubli-Dharwad Municipal Corporation (HDMC). The combined population in the 2011 census was roughly 1 million people, second only to Bangalore among cities in Karnataka. The twin cities source almost all their municipal piped water from the Malaprabha River and Neer Sagar Lake. Hubli-Dharwad has 67 wards, 46 in Hubli and 21 in Dharwad, covering an area of 202 square kilometers, with an average population density of 2362 per square kilometer. The average family size is 5.0 and the average literacy rate is 87%. A total of 138 slums have been identified, representing 19% of the total population.

Sanitation in Hubli-Dharwad

According to the city sanitation report, as of 2011, there was no sewage treatment plant, nor any fecal sludge treatment facility, indicating that all wastewater produced went directly into the local nalas, and all of the fecal sludge collected was dumped in an unsafe and unregulated manner. There is some discrepancy in the data on sewerage; in the city sanitation report data was taken from both the Karnataka Urban Water Supply and Drainage Board (KUWSDB) and the HDMC (see Table 1)

Table 1: Types of Sanitation Access/Lack of Access

	HDMC	KUWSDB
Individual Toilets, discharge to underground drains	70%	50%
Individual Toilets, discharge to open drains	10%	5%
Septic tanks	14%	45%
Pit	3%	
Open Defecation	3%	

Combined collection of wastewater from individual toilets and storm water eventually collects in two existing outfalls; the Gabbur nallah in Hubli and the Madihal nallah in Dharwad. From there it flows out of each city respectively, but much of this nutrient-rich wastewater is diverted and used in local agricultural fields south of Hubli and Dharwad. (WRG 2016) The KUWSDB estimates that in 2011, Hubli-Dharwad produced a total of 78 MLD of wastewater, all of which went untreated.

In a report prepared by WRG in 2016, based on conversations had with authorities at the HDMC, there are plans for installation of five sewage treatment plants (STPs), two of them are planned for Hubli, each of 40 mld treatment capacity in Hubli; and three are planned for Dharwad, two of 20 mld, and one of 25 mld treatment capacity. If all of these plans are implemented, total tertiary treatment capacity of the twin cities would be 145 mld by 2029 (WRG 2016). All of these planned STP investments were coupled with investment in trunk mains as well.

The STP capacity in Hubli-Dharwad, and the network coverage, has now changed from the scenario described in the CSP from 2011. A central part of this study is to verify the current sewer network coverage and STP capacity. Verification of these proposed plans through newspaper articles and publicly available documents put out by the Asian Development Bank (ADB) shows that loan amounts were approved for two modular units of 25 MLD each to be installed at Gabbur (in Hubli) and 1 unit of 24 MLD can be installed at Hossayellapur (in Dharwad). These plants were scheduled for completion in 2016, according to a 2009 document. (ADB 2009) Likewise, an ADB document from 2011 describes two 20 mld plants to be installed at a site in Madihal,

Dharwad (ADB 2011). An ADB document from 2016 shows pictures of the Madhihal plant, as well as detailed plans for trunk main investment and increased coverage of individual latrine connections to the sewer network. We interviewed officials from the Hubli-Dharwad ULB and from the KUIDFC, and obtained cost and capacity estimates for the two STPs completed to date (see Table 1). This gives Hubli-Dharwad a total capacity of 60 MLD; assuming a daily wastewater production of approximately half of the total capacity needed for full coverage by centralized treatment plants.

Table 1: Capacity, construction and cost of completed STPs in Hubli-Dharwad.

Description	**Hubli (near Gabbur)**	**Dharwad (near Madihal)**
Period of construction	2011 - 2015	2013 - 2017
O&M 3 year contract	Ended in 2018	Ends in 2020 or beginning of 2021
O&M Contract	₹1 Cr for three years	(Not available)
Capacity Designed for	40 MLD	20 MLD
Capacity currently used	37 MLD	20 MLD
Capex for UGD installation	₹75 Cr	₹25 Cr
Capex for STP Construction	₹20.35 Cr	₹29 Cr
O & M	₹60 lacs / year - Electricity: ₹1.5 lacs / month - Labour, chemicals, misc. consumables: ₹3 lacs / month	(Not available)

Study Design

Data was gathered through key informant interviews, a household survey and secondary data sources. Data from the Housing Census of India of 2011 at the ward level was obtained from the Census website. This data was used to verify our own data on access to public services as a proportion of the population at the ward level. Public services include details on the proportions

which are connected to open or closed sewers, septic tanks or pits. In collaboration with the Center for Multidisciplinary Development Research (CMDR) we conducted a household survey of 4,000 households over the course of 2 months. Data was collected in all 67 wards, and the sample size for each ward was proportional to the population of that ward (see Appendix 1, Table 1). Interviews were held with officials at the urban local body (ULB) level. ULB representatives were identified both at the local KUWSDB office as well as the HDMC. The goal of these interviews were to ground truth the data collected in the household survey and the housing census; to collect data on the locations and capacity of the STPs, and any information they might have on informal dumping practices. We also interviewed local operators of fecal sludge collection services, in order to get information on the volumes and frequency of collections.

Data Analysis

The SFD generating tool created by GIZ was used to create the SFD (see Figure 1). For this tool, we input the proportions of the population which avail of each option for each of the stages of the sanitation service chain. The sanitation service chain includes five stages: 1) the access point/containment, 2) emptying 3) transport, 4) treatment and 5) disposal/reuse. For the containment stage, we determined that the permeability of the soil and the height of the ground water table make pit an unsafe option. At the transport stage, whether a closed or open sewer was used determined if transport was safe for sewage and discharged supernatant. For the treatment stage, if the sewage, supernatant or fecal sludge was properly treated, it was considered as safe at disposal; otherwise it was considered unsafe.

In our household survey we asked a few key questions in order to classify the type of sanitation access at a particular house. For each household we asked whether they have a toilet at home. If they did not have a toilet at home, we asked if they practiced open defecation or used a public toilet, and if so, how often. If they had a toilet at home, we then asked where that toilet discharged to, with answer options being either a septic tank, a pit, an open drain or an underground drain (UGD). For all households that reported using either a septic tank or a pit, we then asked additional questions about their on-site sanitation system in order to verify the accuracy of their answers. They key follow up questions were: 1) where did the supernatant discharge to (if there was any discharge at all) 2) what was the shape of the pit/tank (these were either circular or rectangular) and 3) what was the floor of the pit/tank made of (concrete, plastic or open). We assumed that any

on-site system that was rectangular, had a closed bottom and an outlet for supernatant, was a septic tank, while anything that was either circular or had an open bottom was a pit. We classified pits which produced an outfall as 'lined pits' and those that did not as 'unlined pits'.

We estimated the percentage of fecal sludge which is collected by first estimating the volume of fecal solids produced, then estimating the volume collected, and taking the ratio of the latter over the former. According to the Indian Census, the population of Hubli-Dharwad in 2011 was 943,000 and the average annual population growth between 2001 and 2011 was 1.84%. Using this growth rate, the projected population in 2018 is 1,071,000. Based on our household survey we estimated that 12% of households had some sort of on-site sanitation system, using our population projection this gives an estimated 129,000 people using on-site sanitation in 2018. Assuming that each person produces, on average, 0.7 kilograms of feces per day, this gives approximately 33 million kilograms of fecal solids going into septic tanks and pits per year.

There are 8 vacuum trucks operating in Hubli-Dharwad, each with a hauling capacity of 4000 liters; we interviewed several in order to collect data on their monthly revenue streams and all on-going costs of business. Based on this data, we estimate that these trucks perform an average of 2 trips per day. We verified this through data collected from households on the frequency that pits are emptied. Only 42% of households with on-site sanitation systems reported having emptied before, and 94% of these households could remember the frequency of pit emptying. Of these, 12 households reported emptying more than once a year, indicating either abnormally small pits or recording error. Of the households which reported an emptying frequency of once a year or less, we calculated a probability that any given household would request emptying services in a year at around 32%. Using our estimate from above for the number of people using a septic tank or pit, and the average household size, this yields a total number of approximately 8000 empties requested per year. For 8 trucks, that averages to 2.8 empties per day, indicating that our estimate of 2 empties per day may be slightly conservative.

We assumed each trip that a vacuum truck made contained a full 4000 liters of solid fecal matter, a likely over estimate in collection volume in order to estimate a maximum rate of collection possible; this assumption allowed us to estimate that a maximum of 71% of fecal solids are collected from septic tanks and pits in Hubli-Dharwad. None of the collected sludge is safely treated before disposal or reuse.

Results and Discussion

We present our SFD in Figure 1; in 2018 we estimate that just under half of all human waste is properly treated before disposal. This is in stark contrast to the estimates made by the SFD created by Grattan Maslin and Heather Purshouse in 2015 (see Figure 2); they estimated that 99% of all human waste was not properly treated before disposal or reuse. The change can be attributed entirely to the construction of the two STPs; on-site sanitation seems to cover roughly the same proportion of the population now as it did then. Building more treatment capacity might increase the proportion of human waste that is safely managed, up from 53% to a maximum of 85%. Beyond that will require increased coverage of underground sewers, or the construction of a fecal sludge treatment plant (FSTP), and conversion of the open-bottomed pits to water-tight septic tanks (we estimate that at least 3% of households are using open-bottomed pits). Additionally, we found roughly 3% of households were not using any latrine at all; we do not know whether this gap is due to poverty (and the relatively high cost of latrine construction), a lack of public toilets or a lack of land tenure; most likely it is due to some combination of all three. A policy solution for these households would need to be formulated in order to make human waste 100% safely treated in Hubli-Dharwad.

Figure 1: An SFD, created using data collected during our household survey (2018).

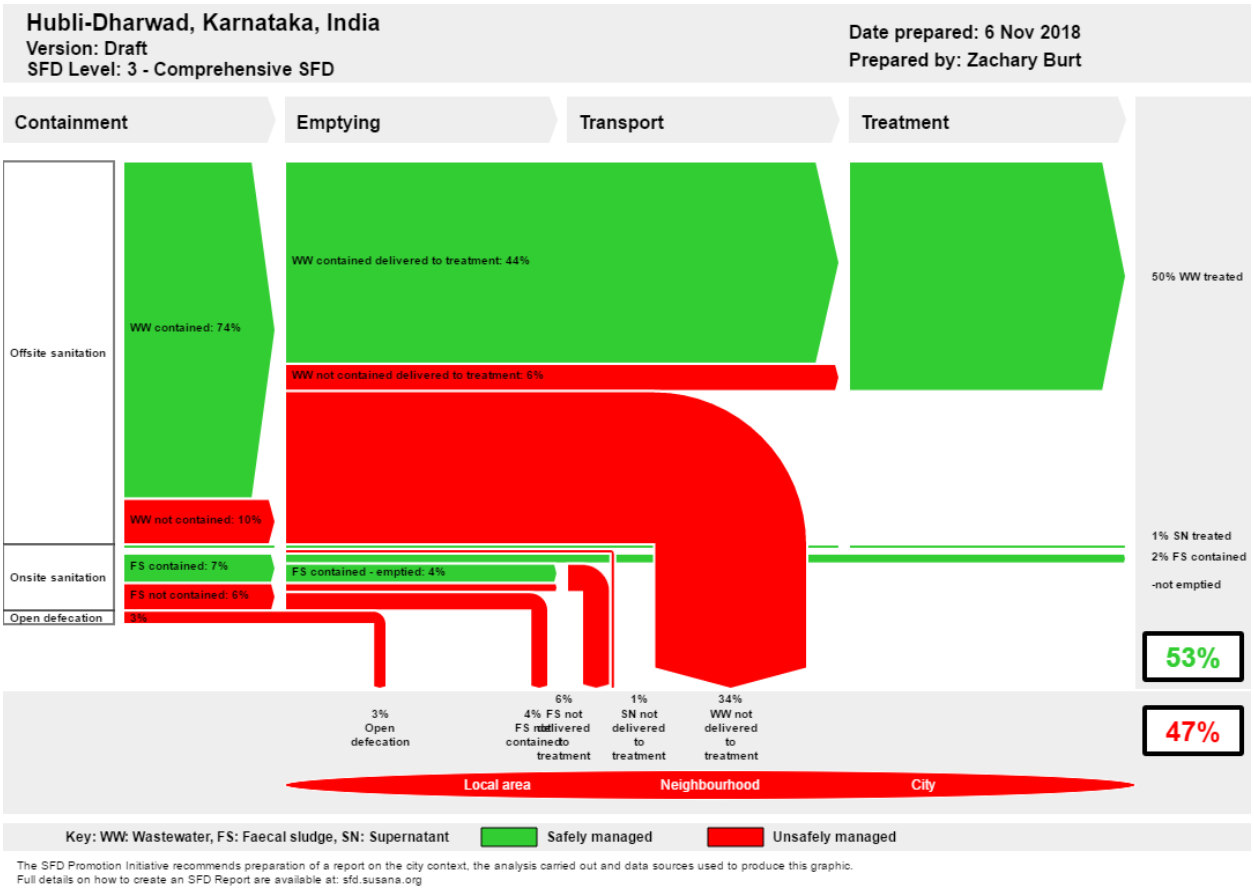
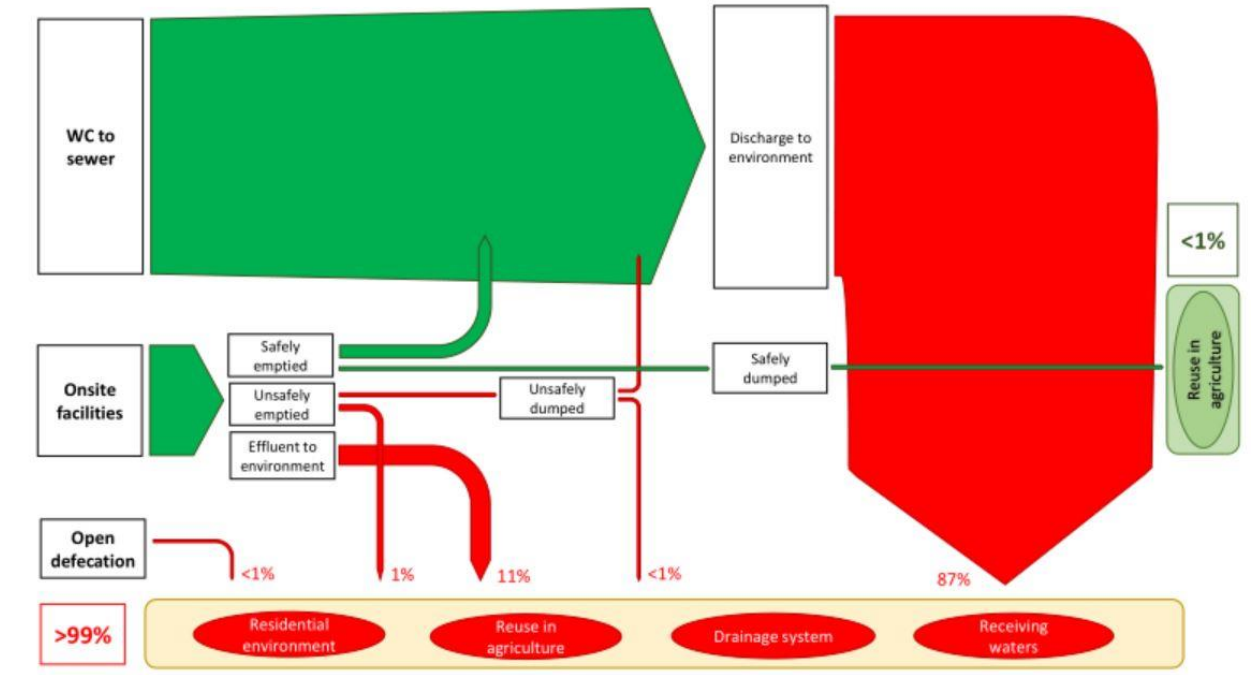


Figure 2: An SFD created in 2015, before the construction of the STPs.



Appendix 1 : Ward Population and Sample Size

The ward household population and slum household population numbers were taken from the CSP, since the original data sources were not publicly available. Those sources were the HDMC and the Asha Kiran Mahiti (AKM). AKM is a web-based application of the Karnataka Municipal Reforms Cell. This is an effort of the Karnataka state government to map and collect vital household data from over 3400 slums all over the state. Sample sizes for each ward were calculated based on a total sample size of 4000, and keeping the number from each ward proportional to the household population of each ward.

Table 1 : Household Population, Slum Household Population, and Sample Size at the Ward Level.

Ward No.	Households	Slum Households	% Slum	Sample Size Target	Total Completed
1	3782	1758	46%	80	80
2	2688	0	0%	60	60
3	2994	425	14%	60	63
4	2820	0	0%	60	63
5	2623	0	0%	60	60
6	2657	1266	48%	60	68
7	2848	470	17%	60	75
8	2496	499	20%	50	53
9	1913	332	17%	40	44
10	2527	339	13%	50	70
11	2504	738	29%	50	48
12	2188	0	0%	50	48
13	2526	1142	45%	50	68
14	3061	353	12%	60	60
15	3061	0	0%	60	59
16	3487	2811	81%	70	75
17	3314	563	17%	70	72
18	3060	1556	51%	60	75
19	3416	212	6%	70	101
20	3366	1649	49%	70	72
21	3830	94	2%	80	80
22	2938	1233	42%	60	64
23	3700	0	0%	80	82
24	3260	260	8%	70	84
25	2713	79	3%	60	60
26	2796	0	0%	60	60
27	3007	562	19%	60	74
28	2471	681	28%	50	47
29	3751	637	17%	80	88

30	3535	130	4%	70	68
31	2435	116	5%	50	58
32	2428	536	22%	50	69
33	2174	211	10%	50	40
34	3856	504	13%	80	84
35	3324	482	15%	70	67
36	3332	1696	51%	70	72
37	4172	587	14%	90	91
38	3769	1108	29%	80	80
39	2947	0	0%	60	60
40	2761	1439	52%	60	69
41	2519	145	6%	50	47
42	2792	581	21%	60	57
43	2621	1116	43%	60	62
44	2707	837	31%	60	69
45	1688	995	59%	40	49
46	2252	0	0%	50	59
47	3179	512	16%	70	73
48	1885	530	28%	40	42
49	3011	245	8%	60	83
50	2192	1687	77%	50	64
51	2251	1187	53%	50	32
52	1980	0	0%	40	68
53	2246	441	20%	50	52
54	2066	119	6%	40	44
55	2356	210	9%	50	50
56	1840	0	0%	40	52
57	2086	0	0%	40	42
58	2302	771	33%	50	53
59	1727	221	13%	40	62
60	3278	0	0%	70	69
61	2158	760	35%	50	61
62	2628	0	0%	60	61
63	3439	0	0%	70	83
64	2768	1200	43%	60	65
65	4189	0	0%	90	90
66	2906	1650	57%	60	78
67	3653	296	8%	80	80
Total	189249	37971	-	4000	4358