

7. 参考資料

7.1 River Water Pollution Trend in Thimphu City

March 2010 ~ April 2011

National Environment Commission

Introduction

Thimphu (the capital of Bhutan) is the biggest city in Bhutan. Recently the city's scale is developing rapidly. Many buildings and apartments are under construction in the city. Therefore many people and huge amount of matter are coming into Thimphu city.

However pollution control and waste management is not catch up with developing speed for protect environment.

This report described how and where Thimphu rivers affected by resident's life in city.

Experimental

Total Nitrogen Analysis

Total Phosphorus Analysis

→*See attached Method Book for Water Analysis (NEC)*

Total Nitrogen (T-N) means sum of ammonium-nitrogen, nitrite-nitrogen and nitrate-nitrogen in the water. It is originate from animal and vegetation. T-N will be increase by sewage, industrial discharge and stock sewage.

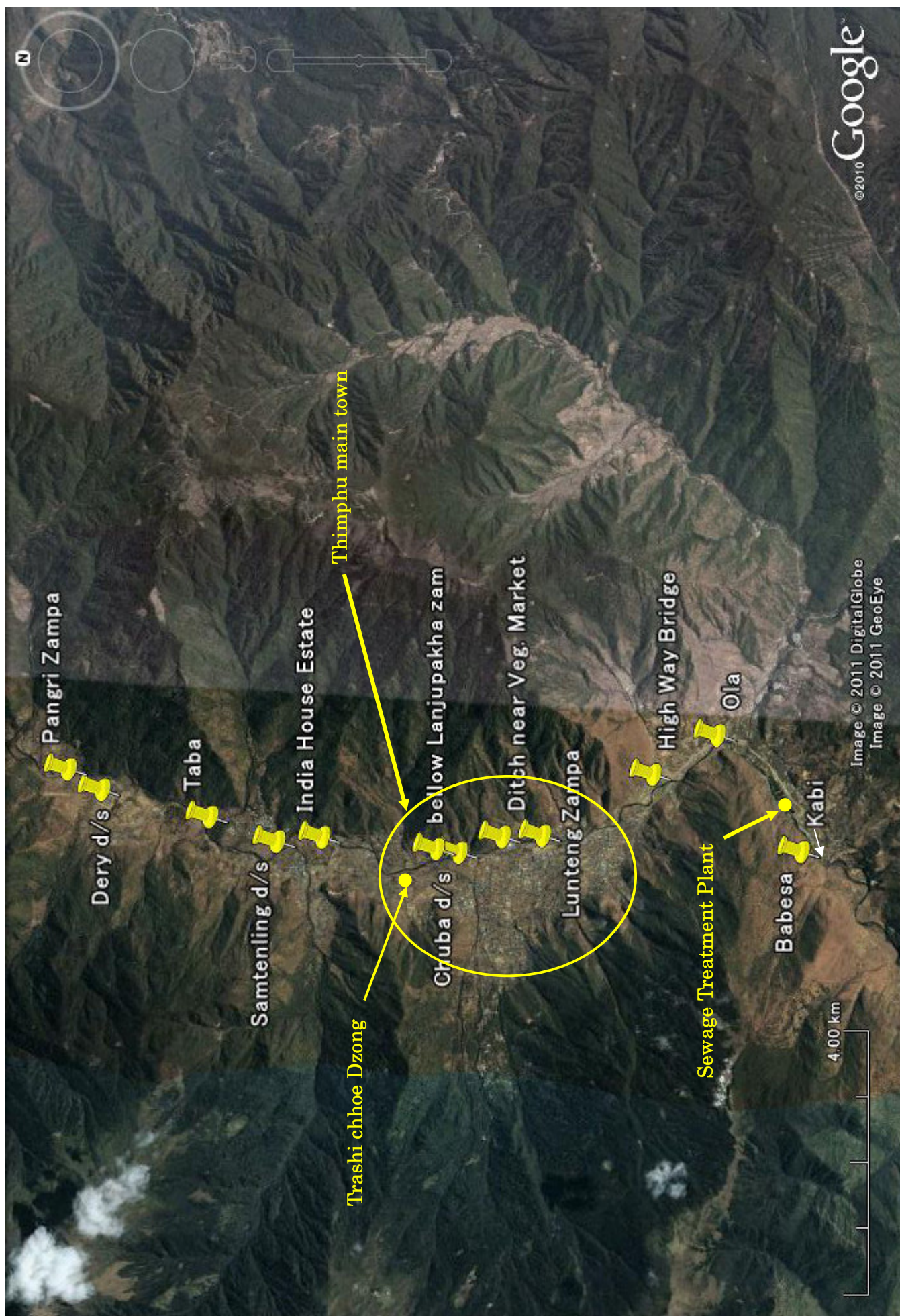
Total Phosphorus (T-P) means sum of inorganic and organic phosphorus in the water. It is originate from animal, vegetation and geology.

T-N & T-P can cause eutrophied water of river and lake.

Location of Monitoring Sites

Wang chhu is a major flowing river in Thimphu valley from north to south. And tributaries are running into Wang chhu from mountain side.

I set monitoring sites inside of Thimphu city's sphere for investigation of water quality difference between up-stream and down-stream. Some tributaries are flowing people's residence area. Therefore, also I researched tributary's effect for pollution of main stream (Wang chhu). (Map: Water Monitoring Sites Map in Thimphu)



Map: Water Monitoring Sites map in Thimphu 2010~2011 (13 sites)

Results

Graph1 & 2 showed comparison of every sites average data (Total-Nitrogen & Total Phosphorus). Near Veg. market Ditch water was highly-polluted. This water was running into main stream (Wang chhu) directly. (Photo 1)

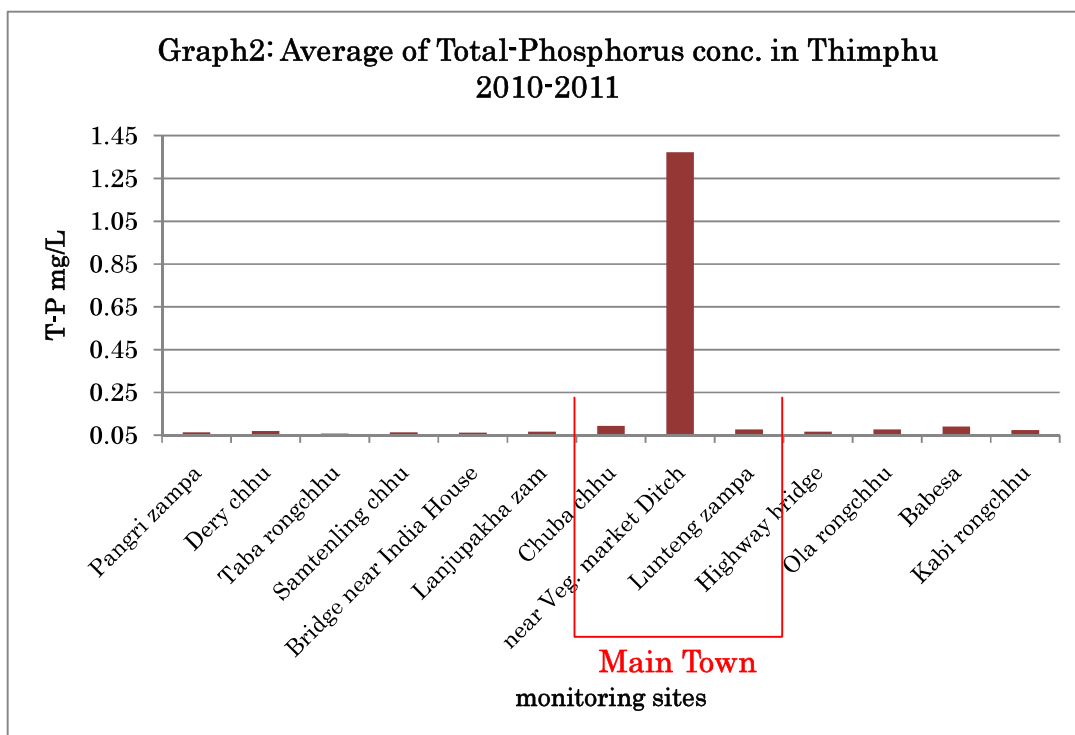
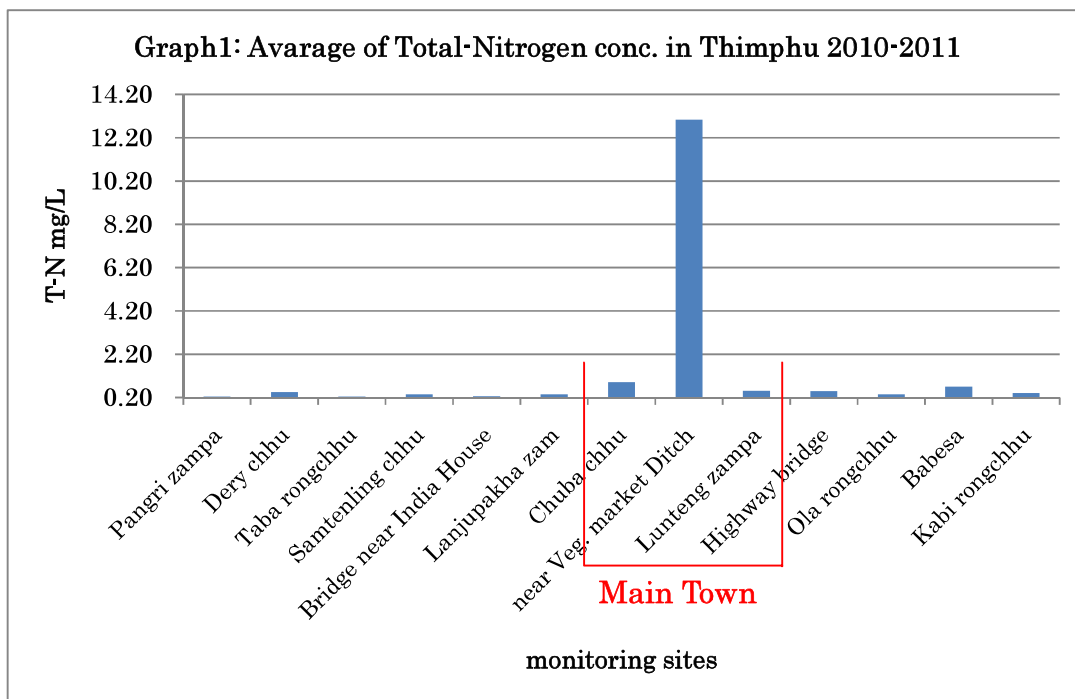
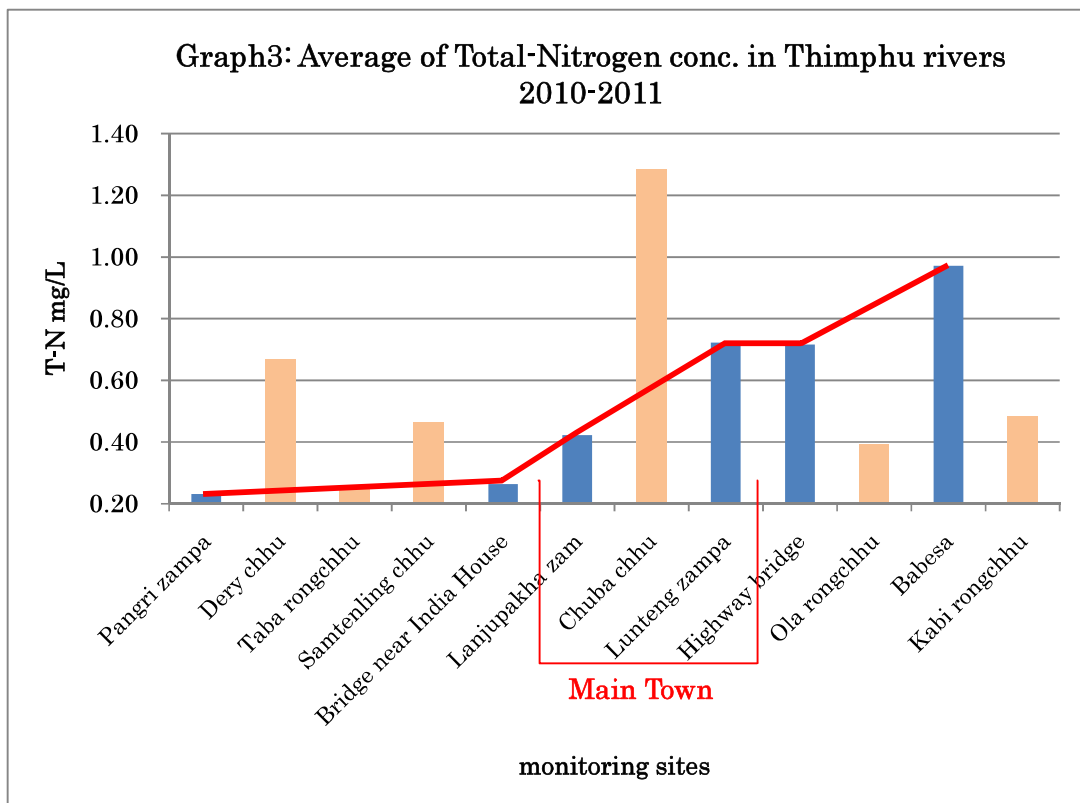
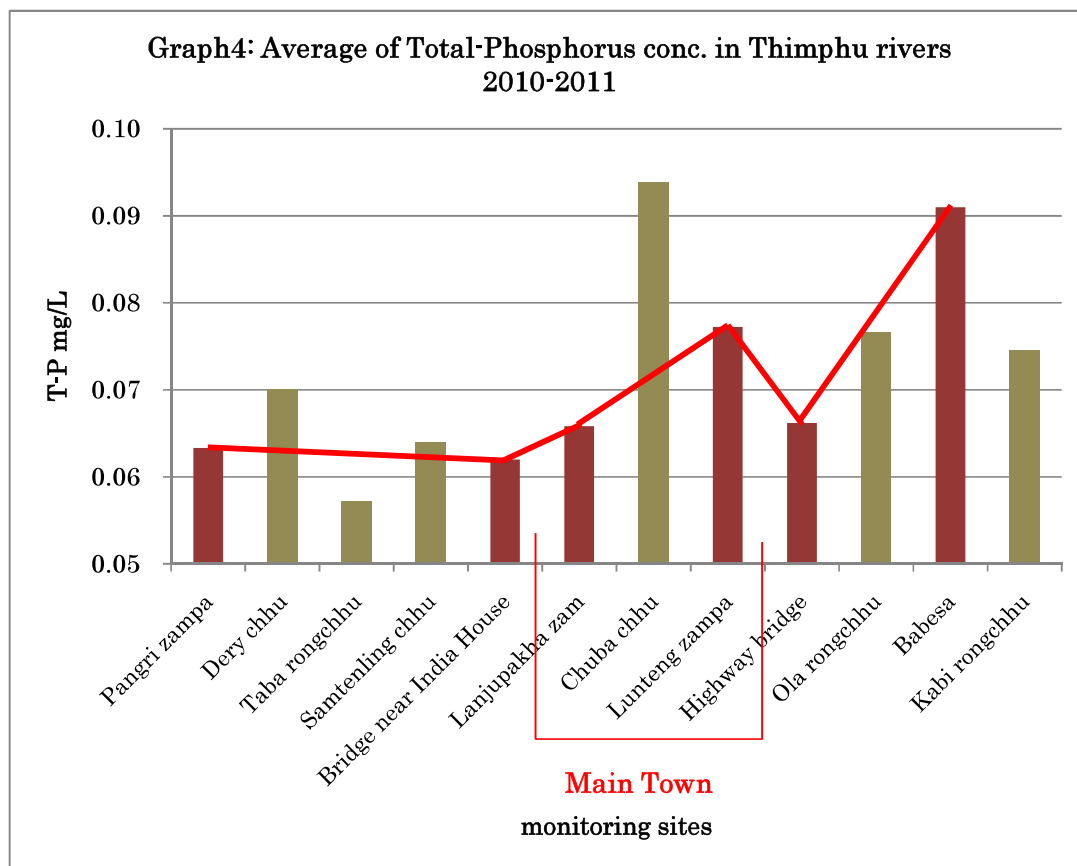




Photo1:
Outlet of “near Veg.
market Ditch”

Graph 3& 4 showed comparison of Wang chhu & tributary data. Line connected with each Wang chhu sites. Down-stream of city water data was higher than up-stream of city. Data showed to increase in polluted level at main town area and continued to increase to Babesa.





Site Observation

Dery chhu is small stream at Dechencholing town (about 7km north from Thimphu). Monitoring site located down-stream of Royal Bhutan Army Camp. There are many rubbish, looked very dirty. And toilet drain was connecting to river directly.



Photo2: Dery chhu

Center; Local toilet in army camp

Right; Local toilet at Dechencholing town

Taba Rongchhu located at Taba town (about 4km north from Thimphu). Rubbish container set stream side but rubbish dumped and mixed in the stream.



Photo3: Taba rongchu and rubbish container at stream side.

Samtenling chhu located side of India House Estate. Barrack houses built by estate and sewage was running into river directly from local toilet also.



Photo4: Samtenling chhu and local toilets

Chuba chhu is flowing tributary in main town. Many buildings and houses were along a riverfront.



Photo5: Chuba chhu

Near Veg. market ditch is running center of city. Therefore ditch exists to city people as the best rubbish dumping site and sewage line.



Photo6: near Veg. market ditch
Center: Rubbish sweeper in ditch at city center
Right: Renewed ditch outlet to Wang chhu

Ola rongchhu site located at Olakha town. Automobile workshop is along riverfront. Before waste oil was flowing from workshop, but now oil-catcher is under construction for prevent oil pollution.



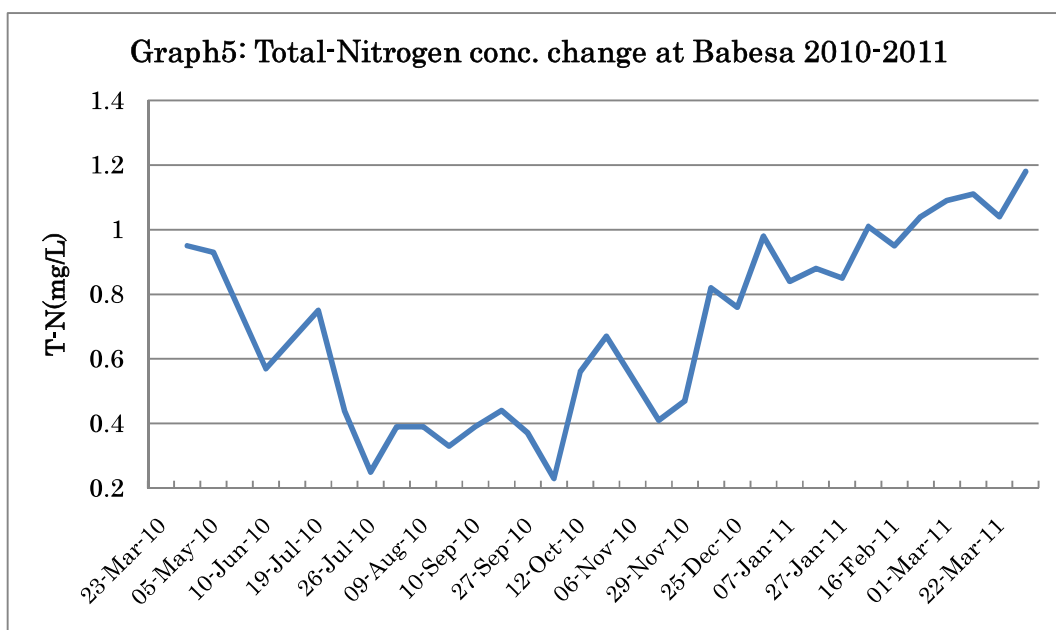
Photo7: Ola rongchhu
Center: Oil flow from workshop
Right: Construction of oil-catcher

Babesa town located at south end of Thimphu city. City sewage treatment plant exists about 1km up-stream from Babesa monitoring site.

Graph5 showed low T-N concentration in monsoon season (rainy season). And T-N conc. was increasing step by step to winter (dry season). This data change should be causing amount of river flow by rain.



Photo8: Babesa monitoring site in dry season
Center; Outlet of sewage treatment plant
Right; Babesa monitoring site in monsoon season



Conclusion and Suggestion

Wang chhu water quality was becoming dirty between main town and down-stream of city compare to up-stream. Tributary and ditch in the city should be causing this pollution trend. Tributary was easy to affect by people's living activity (For example, Dery chhu, Samtenling chhu, Chuba chhu and Veg. market ditch). And river flow also had affected river water quality.

Large scale construction will be make huge impact to river water quality. (Photo9)



Photo9: Wang chhu at Luntengphu, Thimphu
Construction caused to increase of turbidity.

How should we keep balance development and protection of environment?

Firstly, we should know and notice that what happen at site and what is problem to protect nature. For it we have to be in sites frequently and observe conditions.

Secondly, environmental education and enlightenment should be given for all of citizens. Bhutanese manners and morals to environment are still developing. “Don’t throw rubbish into river and on the road” That is simple things and first step for protect environment and nature. And environmental problem is not just government problem but also each person’s subject in the present age. It is very important that improve the common people’s knowledge and minds.

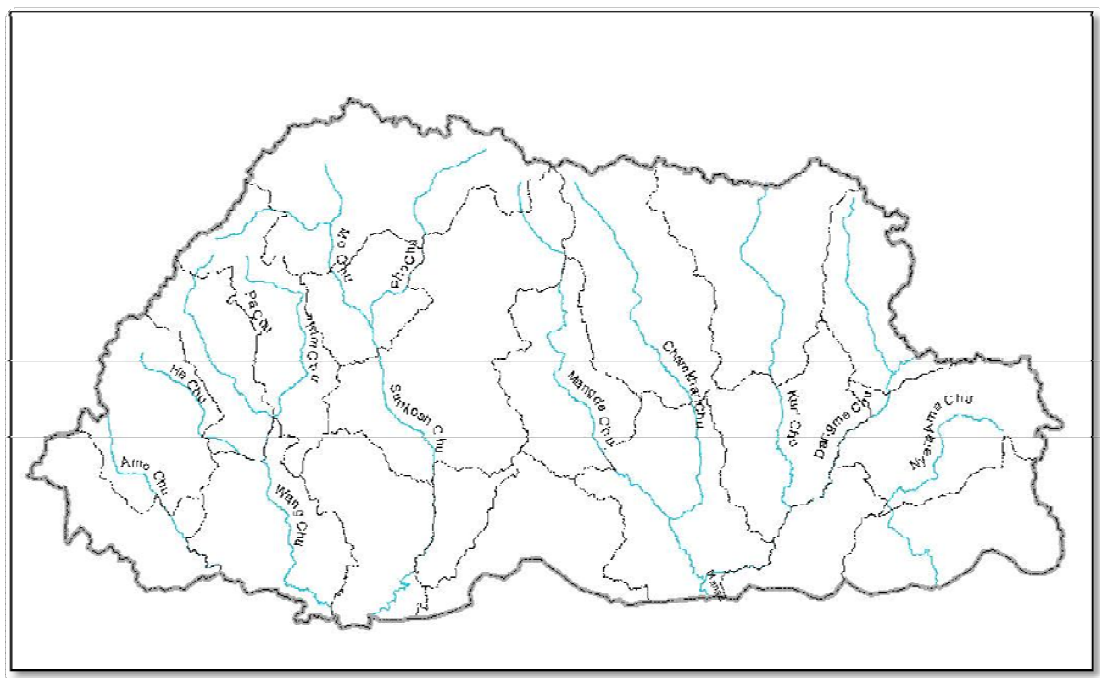
And how should be manage natural environment is eternal theme for government. To keep in close contact is absolutely essential with other ministry, corporation and foreign agency. We should collaborate in addressing global issue because our earth is the one.

People has unlimited desire for matters, convenient life and so on. But our environment has limit of permissible level to development. Therefore we should have modesty to natural environment and we have to control our mind also. That is our duty for next generations.

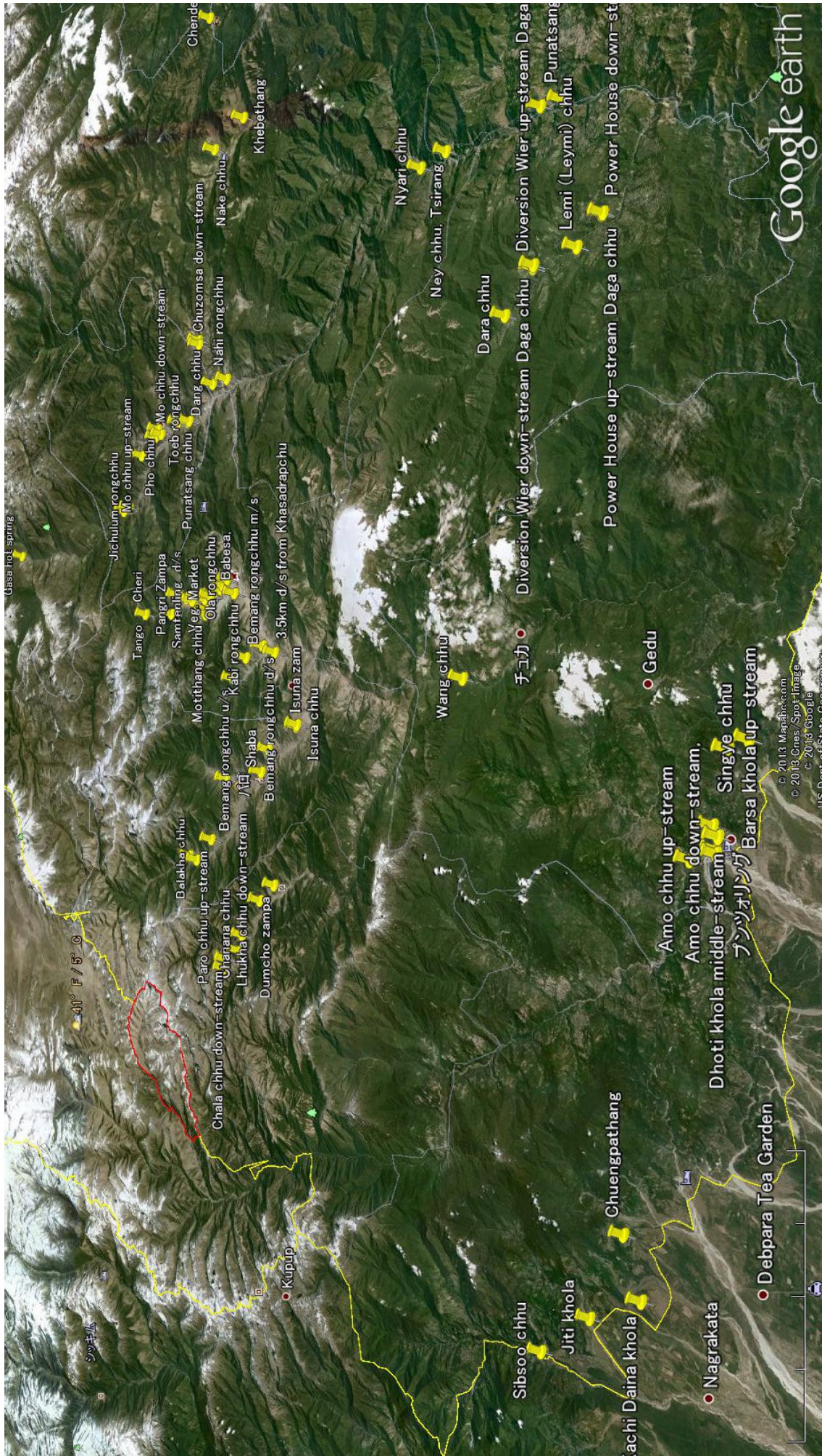
Takeshi Nishimoto

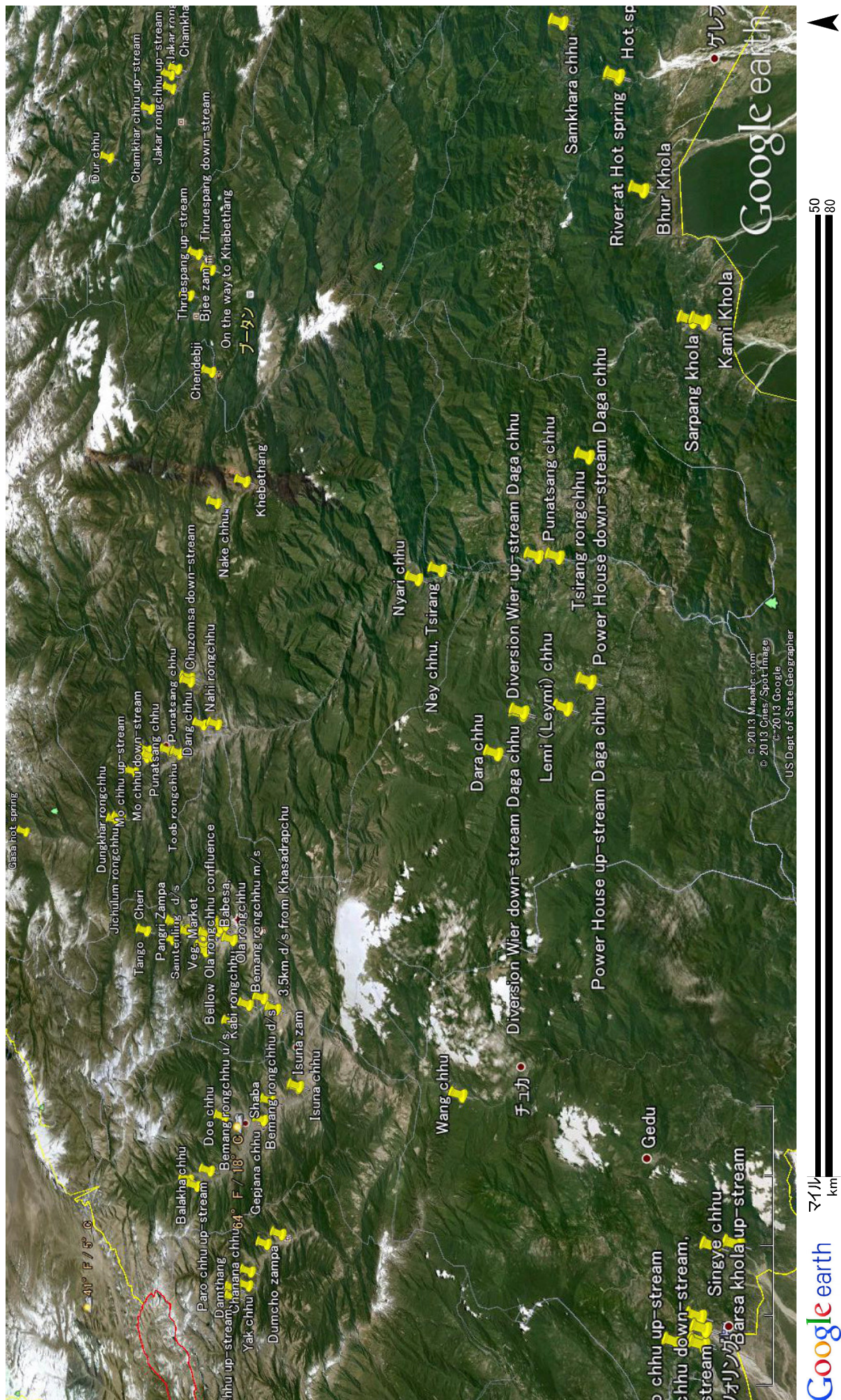
National Environment Commission/JOCV

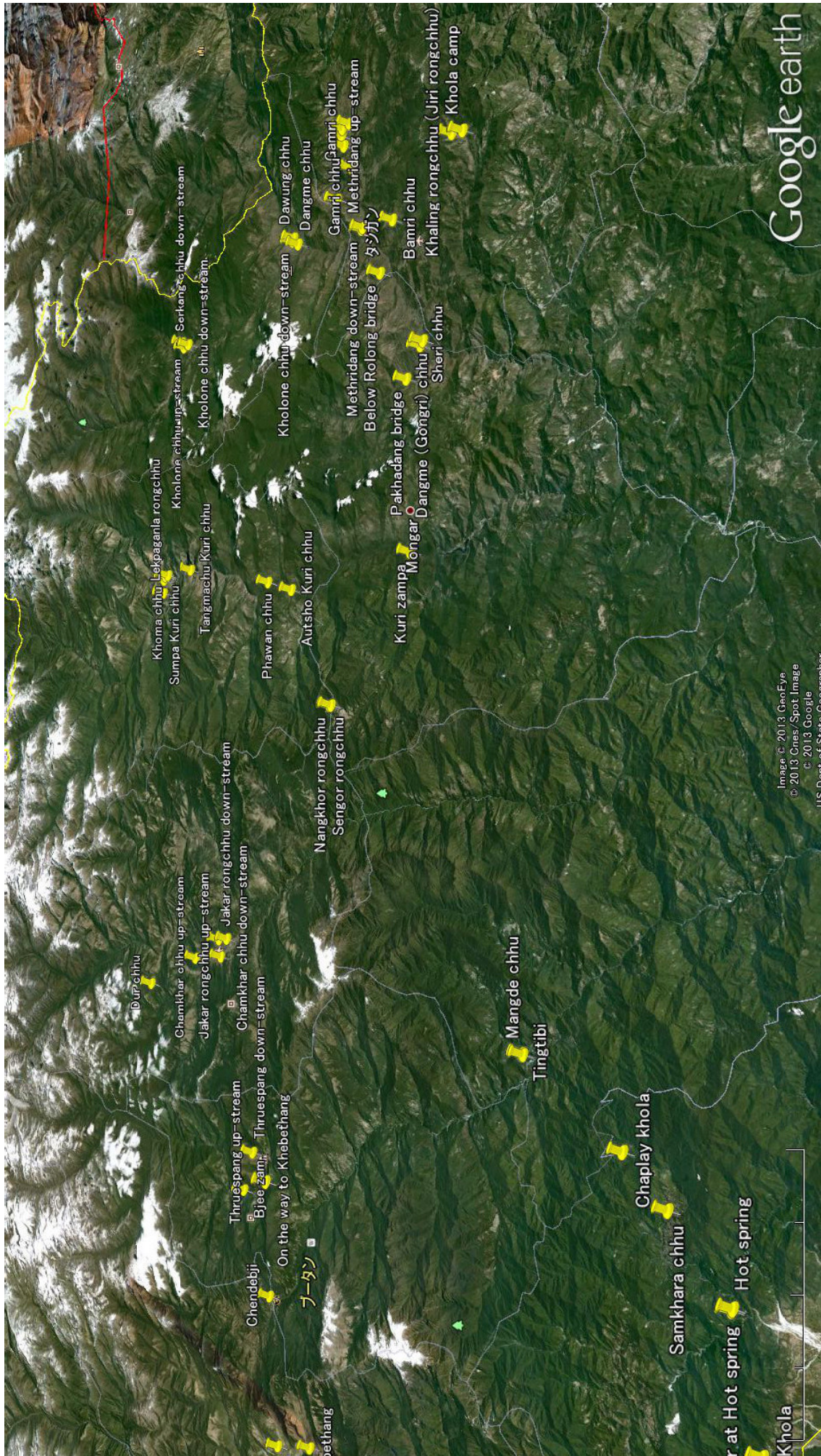
7.2 Water Monitoring Location Map & Data in Bhutan



National Environment Commission







Water Monitoring Data in Bhutan *COD Data (mg/L)

	Site Name, Location, Dzongkhag	1988		1989		1990		2002		2003		2004		2005		2007		2009		2010		2011	
		MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	
Thimphu	Tango, Wang chhu							6.0	13.0	20.0				5.0					0.5				
	Cheri chhu, Thimphu							6.0	6.0	6.0													
	Pangri Zampa (Dechen Choling), Wang chhu							6.0	6.0	6.0		2.0						0.6	0.3	0.7	2.6	0.5	
	Dery chhu up-stream, Thimphu	10.0	10.0	13.0	16.0	10.0	10.0	6.0	8.0	10.0		5.0	0.0										
	Dery chhu down-stream, Dechencholing Thimphu										2.0	35.0						1.5	0.8	2.3	11.8	0.6	
	Taba rongchhu, Thimphu										2.4	5.0						0.5	0.3	1.0	2.3	0.5	
	Samtenling rongchhu down-stream, Thimphu																						
	India House Estate, Wang chhu																	0.5	0.3	1.0	2.3	0.5	
	Laniupakha Zam, Wang chhu																	0.5	1.1	3.3	0.5	0.6	
	Phajodhing chhu (Chuba chhu up-stream), Thimphu										6.8							4.6					
	Motithang chhu (Chuba chhu up-stream), Thimphu										6.8	5.0						6.4					
	Chuba chhu middle stream, Thimphu																	5.2					
	Chuba chhu down-stream, Thimphu										4.6							1.3	2.7	5.6	1.3	1.8	
	Changankha stream, Thimphu																						
	Ditch at swimming pool, Thimphu																						
	The ditch near Veg. Market, Thimphu																						
	Veg. Market, Wang chhu																						
	Lunteng Zampa, Wang chhu																						
	Changjili, Wang chhu										0.2		5.0					2.3					
	Luntengphu highway bridge, Wang chhu								6.0	6.0	6.0		5.0										
	Unknown site on Wang chhu, Thimphu town1	10.0	13.3	18.7	24.0	10.0	10.0																
	Unknown site on Wang chhu, Thimphu town2	10.0	32.0			10.0																	
	Ola rongchhu, Thimphu										2.4												
	Below Ola rongchhu confluence, Wang chhu																						
	Babesa, Wang chhu		16.7			10.0	10.0	6.0	7.0	8.0	0.2	5.0	5.0					1.7	0.9	1.6	3.5	0.8	1.2
	Kabi rongchhu, Thimphu																		1.3	2.1	3.2	1.1	1.5
Benang rongchhu up-stream, Thimphu																						1.9	
Benang rongchhu middle-stream, Thimphu																						0.5	
Benang rongchhu down-stream, Thimphu																						1.0	
Benang rongchhu, Bjemina zampa Thimphu										0.2												0.5	
3.5km down-stream from khasadrapchu, Wang chhu																							
Paro	Paro chhu up-stream, Drukgyel																						
	Balakha chhu, Paro							4.6	6.8	8.10									1.0				
	Paro chhu up-stream, Satsam							6.0			0.2	5.0						0.5					
	Doe chhu, Paro																	0.9					
	Gejjana chhu, Bondev Paro										0.2	*5-10											
	Shaba, Paro chhu																						
	Isuna zam, Paro chhu							5.10			0.2	0.2	0.2										
	Isuna chhu, Isuna Paro																						
	Tamchoe drupchhu, between Isuna and Chuzom Paro																	2.9					
	Drukgyel water source monitoring, Paro																	0.0					
	Druk path water monitoring, Paro																						
Haa	Damthang, Haa chhu up-stream							0.2	2.6	6.0		10.0							0.9				
	Chala chhu up-stream, Damthang Haa																						
	Chala chhu down-stream, Damthang Haa																	1.1					
	Yak chhu, Haa																	1.7					
	Chanana chhu, Gvensa Haa																	0.9					
	Lhukha chhu middle-stream, Haa																						
	Lhukha chhu down-stream, Haa																						
	Dumcho zampa, Haa chhu down-stream							10.0			0.2	5.0							1.8				
																		1.1					

Water Monitoring Data in Bhutan *COD Data (mg/L)

	Site Name, Location, Dzongkhag	1988		1989		1990	2002		2003		2004	2005	?	2007	2009		2010		2011	
		MIN	AVG	MAX	MIN		AVG	MAX	MIN	AVG					MAX	MIN	AVG	MAX	MIN	AVG
Chhukha	Wang chhu, down-stream of Power House Chhukha										20-50	5.0								
	Gedu stream, Gedu Chhukha																			
	Singye chhu, Pasakha Chhu																			
	Barsa khola up-stream, Pasakha Chhukha																			
	Barsa khola, Industreal area Pasakha Chhukha																			
	Ano chhu up-stream, about 4km from boundary Puentsholing Chhukha						2.4													
	Dhoti khola up-stream, Puentsholing Chhukha									0.2										
	Dhoti khola middle-stream, Puentsholing Chhukha																			
	Dhoti khola, at Dorregchhu zam Puentsholing Chhukha									2.4										
	Dhoti khola down-stream, at Puentsholing High school Chhukha																			
Samtse	Ano chhu down-stream, about 100m from boundary Puentsholing Chhukha									2.0										
	Kharbandi (before filter), Puentsholing city corporation water supply station Chhukha																			
	Kharbandi (after filter), Puentsholing city corporation water supply station Chhukha																			
	Chungpathang, Samtse																			
	Kachi Daina khola, Samtse																			
	Jiti khola, Jiti Samtse																			
	Sibsoo chhu, Sibsoo Samtse																			
	Gathvia, Subbagaon Samtse																			
	Gasa hot spring, Gasa															44.0				
	Lava Masagang trek monitoring, Gasa 2009																			
Gasa	Lava Masagang trek monitoring, Gasa 2011																			
	Dungkhar rongchhu, Punakha																			
	Jichulum rongchhu, Punakha																			
	Mo chhu up-stream, Punakha						2.0			10.0				1.9	0.5					
	Nvakulum chhu, Punakha																			
	Mo chhu down-stream, up-stream on confluence with Pho chhu Punakha									0.2										
	Pho chhu, Suspension bridge Punakha						6.8													
	Punatsang chhu, Khurthang Punakha						10.0			0.2										
	Toeib rongchhu, Punakha											10.0		1.5	0.6					
	Punakha	Punatsang chhu, Misina bridge Punakha																		
Chhuzadongkha chhu, Punakha																				
Punatsang chhu, 8 chortens Wangdue Phodrang																				
Punatsang chhu, Tsangchhu bridge (Wangdue check post) Wangdue Phodrang												5.0								
Chuzomisa up-stream, Wangdue Phodrang							5.0			0.2										
Chuzomisa down-stream, Wangdue Phodrang																				
Dang chhu, suspension bridge near Army camp Wangdue Phodrang																				
Nali rongchhu, Hesothangkha Wangdue Phodrang							0.2													
Nvari chhu, Nvarachu Wangdue Phodrang																				
Wangdue Phodrang		Punatsang chhu, Nochenhang bridge Wangdue Phodrang						5.0												
	Punatsang chhu, Fishery park Wangdue Phodrang																			
	Nake chhu, Phobjikha Wangdue Phodrang																			
	On the way to Khebethang, Wangdue Phodrang													0.0						
	Khebethang, Nature study Wangdue Phodrang																			
	Chukagey, about 10m u/s from intake Wangdue Phodrang									0.2										
	Gankha chhu, Wangdue Phodrang									0.2										
	Narmo Isro, outlet from tank, Wangdue Phodrang									0.2										
	Zachhiuna, Wangdue Phodrang									0.2										
	Dagana	Daga chhu, Dagana																		
Diversion Wier up-stream Daga chhu, DHPC * Chitsathang Dagana																	0.9	1.5	2.1	
Diversion Wier down-stream Daga chhu, DHPC * Chitsathang Dagana																	2.5			
Lemi (Levni) chhu, Dagana																				
Power House up-stream Daga chhu, DHPC * Balevgang Dagana																	0.8	1.1	2.3	
Power House down-stream Daga chhu, DHPC * Balevgang Dagana																	2.5			
Buedulum chhu, Dagana																				
Tanga chhu, Dagana																				
Punatsang chhu, Sunkosh Dagana										0.2										
Tsirang		Nev chhu, Tsirang																		
	Chache chhu, Tsirang																			
	Tsirang rongchhu, Tsirang															2.9				
	Dhara chhu, Tsirang																			

Water Monitoring Data in Bhutan *COD Data (mg/L)

	Site Name, Location, Dzongkhag	1988		1989		1990		2002		2003		2004		2005		2007		2009		2010		2011	
		MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	
Sarpang	Sarpang khola, Sarpang zam Sarpang																						
	Kami khola, at check post Sarpang																						
	Bhur khola, Jimeling bridge Sarpang																						
	Bhur small stream, Sarpang																						
	Hot spring, Gelephu Sarpang																						
Trongsa	River at Hot spring, Gelephu Sarpang																						
	Samkhara chhu, Samkhara Sarpang																						
	Chendeji up-stream, Trongsa																						
	Chendeji, Chendeji chorten Trongsa																						
	Bhee zam, Mangde chhu(at check post) Trongsa							0.2						13.0							1.1		
Bumthang	Thruespang up-stream, Trongsa town													10.0							1.8		
	Thruespang down-stream, Trongsa town													13.0		0.6					2.3		
	Lanchela chhu, Trongsa																						
	Dur chhu, Bumthang																						
	Chamkhar chhu up-stream, Bumthang							2.0													1.1	2.5	
Zhemgang	Jakar rongchhu up-stream, Jakar Bumthang																				3.8	1.5	
	Jakar rongchhu down-stream, Chamkhar bazaar Bumthang																				5.0	3.8	
	Chamkhar chhu down-stream, Bumthang							0.2					5.0								1.1	2.3	
	Chumney chhu, Bumthang																						
	Gav Zam chhu, Bumthang																						
Lhuentse	Tingtibi, MANGDECHHU check post Zhemgang																						
	Mangde chhu, Zhemgang																						
	Chaplay khola, Zhemgang																						
	Dagpai chhu, Zhemgang																						
	Yamagang chhu, Zhemgang																						
Mongar	Lebaganla rongchhu, Lhuentse town																						
	below Lhuentse Dzong kuri chhu, Lhuentse																						
	Khoma zampa kuri chhu, Lhuentse							0.2															
	Khoma chhu, Lhuentse							0.2														1.1	
	Sumpa kuri chhu, Lhuentse												20.0										
Trashi Yangtse	Tangmachu kuri chhu, Lhuentse																						
	Phawan chhu, Autsho Lhuentse																						
	Autsho kuri chhu, Lhuentse																						
	Sengor rongchhu, Mongar																						
	Kuri zampa, Kuri chhu Mongar							0.2							10.0								
Trashing	Pakhadang bridge, Mongar							2.4															
	Sheri chhu, Mongar							0.2															
	Dangme (Gongri) chhu, near confluence with Sheri chhu, Gongri zampa Mongar							0.2															
	Kholone chhu up-stream, Trashi Yangtse town																						
	Serkang chhu up-stream, Trashi Yangtse town																						
Pemagatshel Sandrup Jongkhar	Serkang chhu down-stream, Trashi Yangtse town							0.2						13.0									
	Kholone chhu down-stream, Trashi Yangtse town							0.2						13.0									
	Dangme chhu, Gomkora Trashi Yangtse																						
	Kharthidag up-stream, Rangjung Trashing																						
	Kharthidag down-stream, Rangjung Trashing							0.2							5.0								
Pemagatshel Sandrup Jongkhar	Gamri chhu, Buna Rangjung Trashing																						
	Thungdi chhu, Trashing																						
	Godhi chhu, Trashing																						
	Gamri chhu, at Ritu bridge Trashing							0.2															
	Metridang up-stream, Trashing																						
Pemagatshel Sandrup Jongkhar	Metridang down-stream, Trashing																						
	Below Rolong bridge, on Trashing & Mongar Dzongkhag border																						
	Bamri chhu, Pam Trashing																						
	Khaling rongchhu (Jiri rongchhu), Khaling Trashing																						
	Khola camp, Khaling Trashing																						
Pemagatshel Sandrup Jongkhar	Thrimshing chhu, Trashing																						
	Nangkhor rongchhu, Pemagatshel																						
	Sandrup Jongkhar up-stream, Sandrup Jongkhar														5.0								
	Sandrup Jongkhar down-stream, Sandrup Jongkhar														5.0								
																						0.6	