Department of Geology
University of Dhaka

Final Report

On

Water Zone Mapping of the Ukhiya – Teknaf region, Coxs's Bazar, Bangladesh

As a fulfillment of 'Activity 2.2: Preparation of water zone maps for the study area and development of practical field manuals for individual zone detailing location, type (groundwater/surface water), and amount of available water, suitable abstraction technology, potential contamination issues, and their prevention/remediation criteria, temporal variability in water availability and/or quality, etc' of Dhaka University project "Water Resources Zoning Using Existing Data and Ongoing Programme Information for Assessing Water Resources Potential and Suitable Technology within Refugee Camps and Adjacent Host Community Areas In Cox's Bazar" funded by UNICEF-Bangladesh and supported by DPHE-Cox's Bazar.

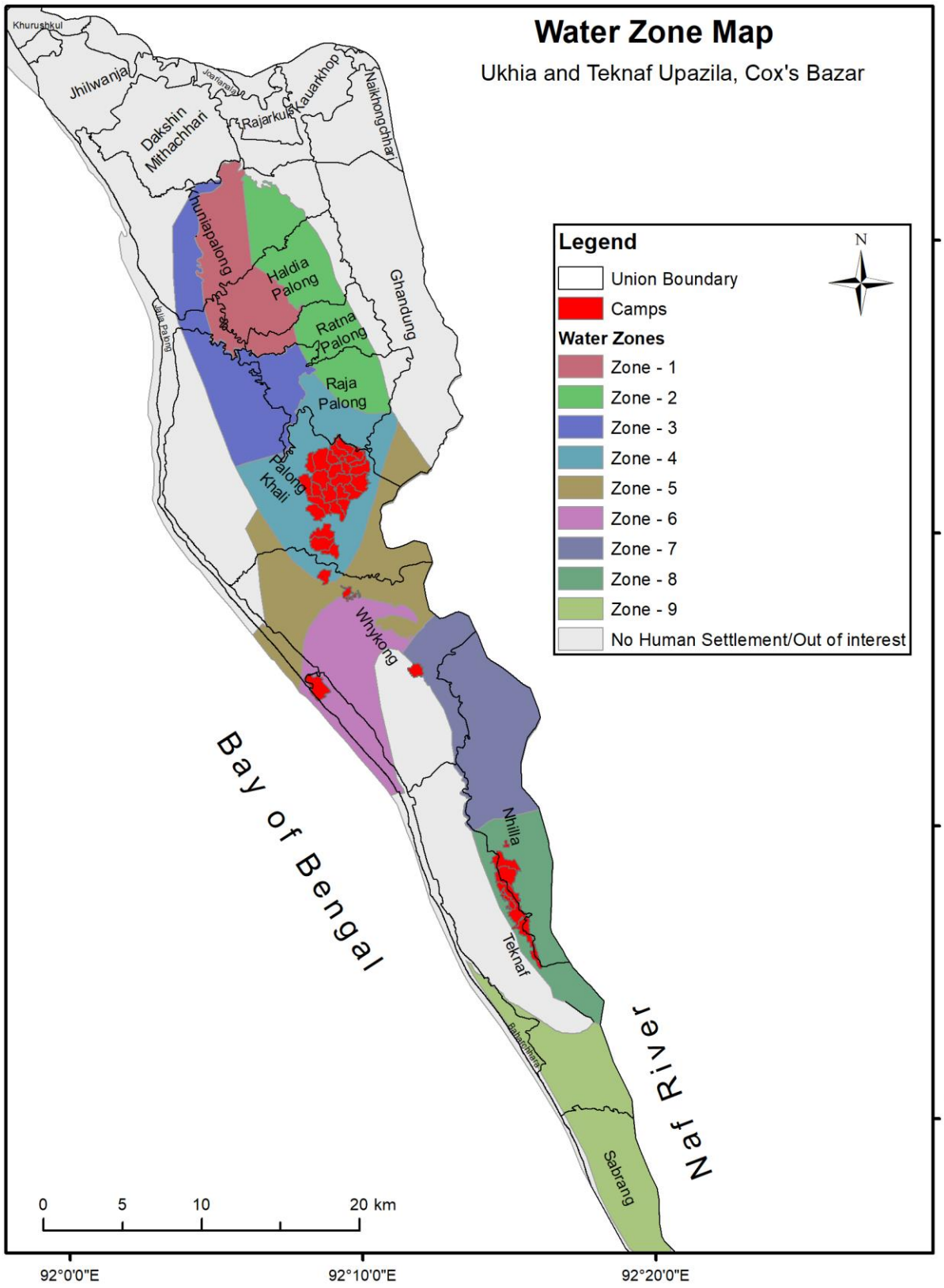
July 2021

unicef
for every child

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-1

WATER ZONES


Water Zone Map
Ukhia and Teknaf Upazila, Cox's Bazar
Legend
Union Boundary
Camps
Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Naikhongchhar
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER ZONE-1

Geographic Location

Khunia Palong Union

- Khunia Palong Mouza
- Dhoa Palong Mouza
- Dariar Dighi (Western Half)
- Dhechua Palong (Western part)

Haldia Palong Union

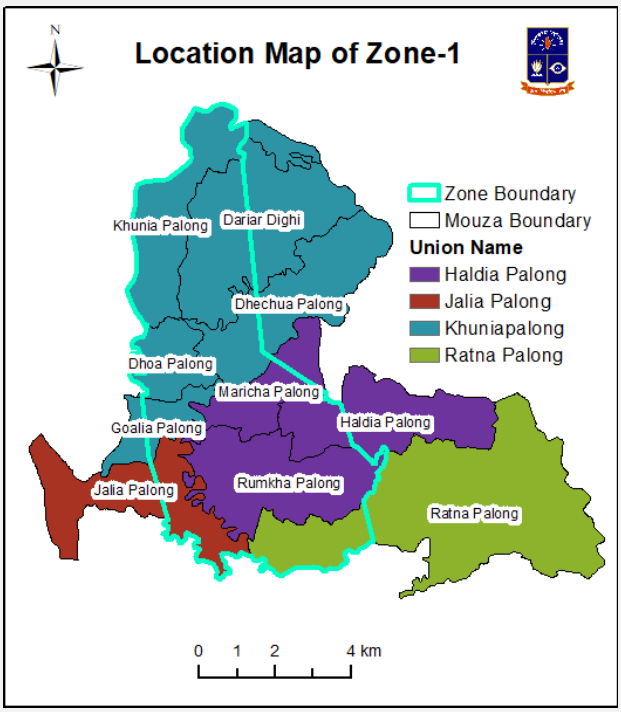
- Rumkha Palong Mouza
- Maricha palong (Western part)
- Haldia Palong (Western part)

Jalia Palong Union

- Jalia Palong Mouza (Eastern Part)

Ratna Palong Union

- Ratna Palong Mouza (Western Part)



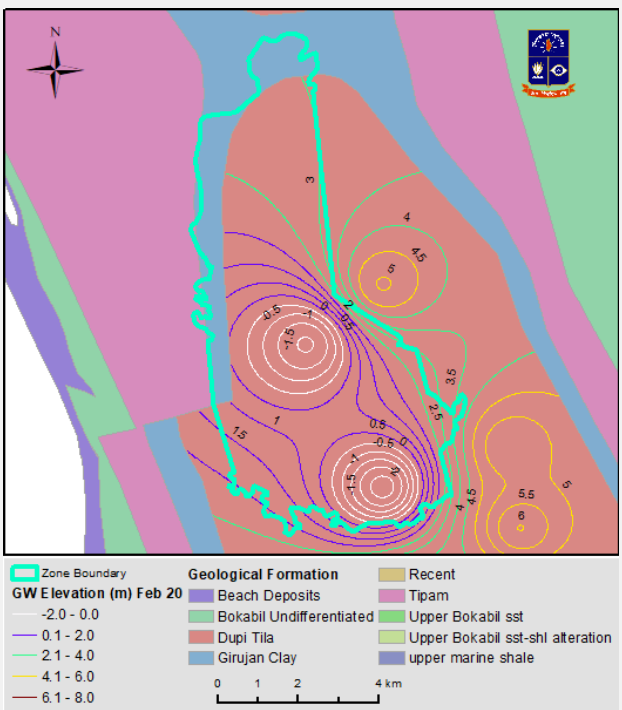
Aquifer Description

Dupi Tila Aquifer

- **Depth**: Surface to about 250m
- **Type**: Unconfined to semi-confined
- **Nature**: Highly heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively low transmissivity and low storativity in this zone

Tipam Aquifer

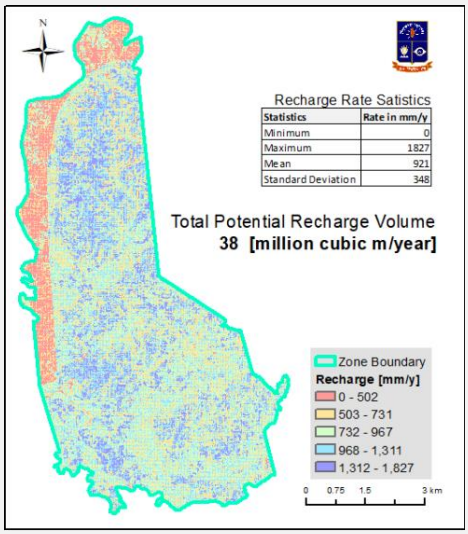
- **Depth**: Inferred below 350m
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity



Groundwater Availability and Abstraction

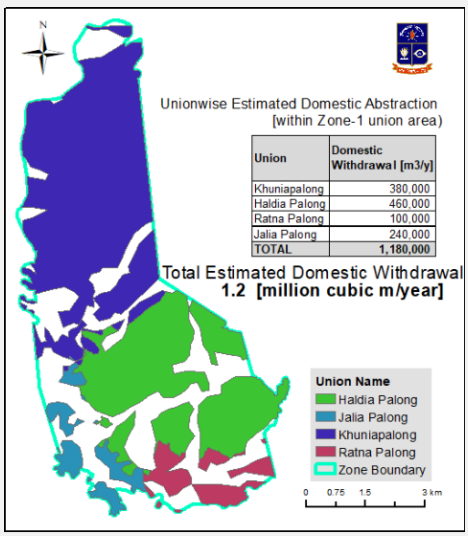
Groundwater Recharge Potential

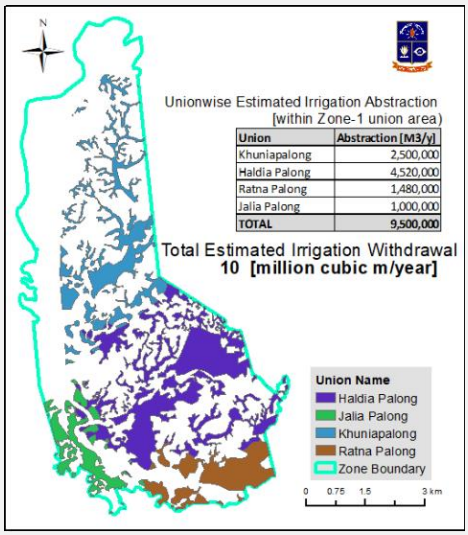
- Potential recharge in Dupi Tila in Zone 1 is 38 [Mm^3/y]*
- Recharge time May to September
- Highest in June to August
- Tipam gets recharged in hilly region outside zone-1 where it is exposed. Exact recharge volume for Tipam in zone-1 is difficult to estimate.



Groundwater Abstraction

- Estimated domestic consumption 1.2 Mm^3/yr considering 50 litre/person/day
- Estimated irrigation consumption 10 Mm^3/yr considering 0.75m water use per unit irrigation area per year



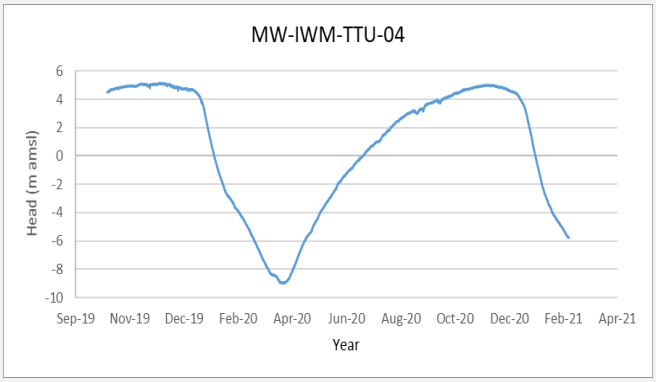


**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

Seasonal Fluctuation

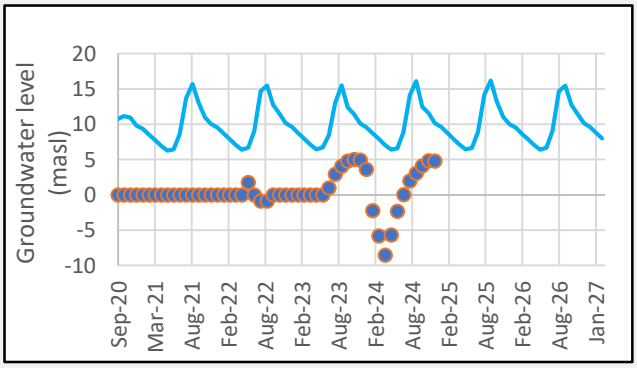
- >14 m in upper part of Dupi Tila (at around 70 m depth)
- In the lower part seasonal fluctuation is reported to be a few meter by local people
- Because potential recharge > withdrawal groundwater level returns close to land surface even after high seasonal drawdown caused by irrigation pumping
- Unusual seasonal drawdown indicates very low storage and transmissivity of the aquifer; needs to be verified.



>14 m fluctuation had found in a so called 161.5m depth well (IWM-TTU-04). According to local information, this pattern is similar to intermediate depth (~70m) not to the groundwater level pattern of the reported depth of the piezometer. Therefore, we assumed the reported piezometer depth may be wrong.

Groundwater Level Trend

- Groundwater level trend is not alarming here except some seasonal fluctuation (~14m)
- Dupi Tila formation in zone-1 has good permeability which recovered almost full in monsoon period, that does not allowing groundwater mining so far
- Also it has could be mentioned that there is no relation of camp pumping and this seasonal fluctuation of groundwater in zone-1



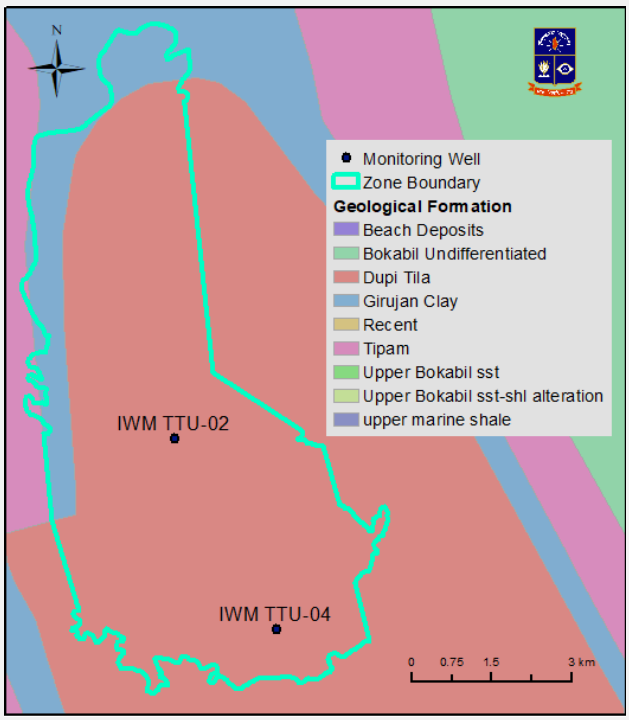
Solid line is model predicted head and dots are observed head in the IWM_TTW-04

Groundwater Quality

The following water quality results are based monthly water quality analysis in two wells (**IWM TTU-02** and **IWM TTU-04**) for a period of 9 months. Reported well depths are in the range of 160 to 170 m, however, there is uncertainty in the well depth and they could actually be around 70 m.

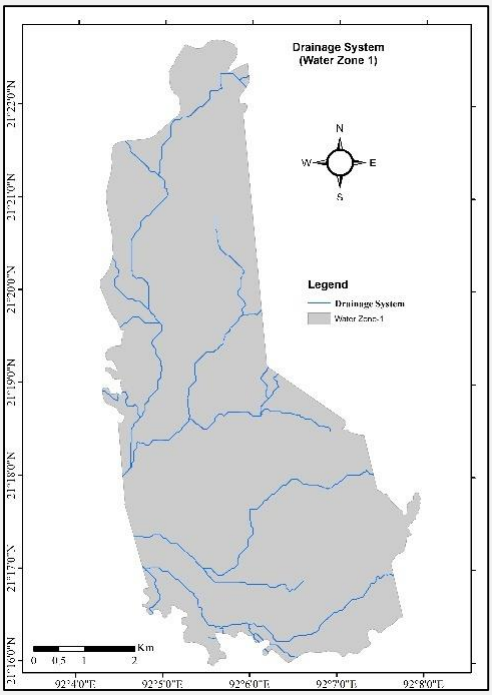
- **Salinity:** Fresh drinking water
- **Water type:** Na-bicarbonate
- **Heavy Metals:** Below Bangladesh Standard for Arsenic and Manganese. Iron found to be high in in one well right after the completion of the wells, otherwise found below Bangladesh Standard throughout the year.
- **Nitrate:** Below Bangladesh standard
- **Fluoride:** Below Bangladesh standard
- **Microbial Contamination:** There is no trace of E-coli found in the monitoring wells

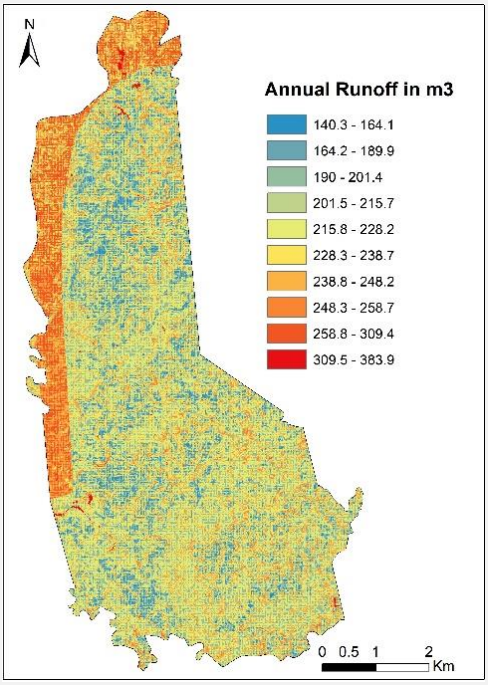
Parameter	Bangladesh Standard for Drinking Water ECR'97	No of samples	Max	Min
pH	6.5-8.5	2	7.75	6.53
Temp (˚C)	20-30˚C	2	28.5	25.5
EC (uS/cm)	N/A	2	481	312
ORP/Eh	N/A	2	-7	-127
Fe mg/l	0.3-1.0mg/l	2	1.24	0.124
E-Coli	0 cfu	2	Nil	
Mn	0.1 mg/l	2	0.052	0
Fl-	1.0 mg/l	2	0.314	0.143
NO3-	10 mg/l	2	3.73	0



Surface Water Potentiality

- Surface water is covering 160 hectors (approx.) with two major streams; Reju canal is the prominent stream
- Densely populated and cultivated land is the main surficial characteristics of this zone
- Annual rainfall ranges from 3700 to 4300 mm
- Some seasonal/ intermittent local stream develops in wet season
- Relief is relatively low except the western part
- High runoff generates along the western margin where Girjuan Clay is exposed
- Annual surface runoff is 90 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage
- There are hilly terrain in the western boundary of the Zone, surface water reservoir may be created in that part





Summary and Recommendation

Summary

- Groundwater potentiality is moderately good
- Surface water potentiality is low
- Estimated annual water demand is around 12 Mm^3/yr where estimated annual recharge is well higher then demand ~38Mm^3/yr
- Despite high potential recharge groundwater level drops more than 14 m during irrigation season at shallow depth
- Sharp declination of groundwater level may be due to high irrigation pumping and low yield and transmissivity of the aquifer
- Camp pumping is likely have no influence in zone so far
- Water quality is good for drinking purpose

Challenges and Issues

- Shallow (~70 m) domestic wells get defunct during irrigation season
- Many shallow irrigation well also become defunct due to high water table depth

Overall Recommendation

- Groundwater can be used but abstraction technology must be appropriate for the high seasonal water table
- Tara-pump can be used for shallow hand tubewells
- Deeper wells (>150 m) can be considered for domestic supply
- Irrigation pumping should be kept shallow despite high seasonal water table. Pump technology that works under deeper depth should be considered
- Increase irrigation water efficiency

Technical Recommendation

- Suggested Screen Depth:
    - Domestic : 150m-180m
    - Irrigation : 45m-80m

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
- Required at least three (03) more sets of multi-depth piezometer
- Monitoring of both groundwater level and monthly water quality for at least a year
- Couple of capacity building program on proper groundwater management with stakeholders for sustainable water supply
- Feasibility for artificial recharge in wet period can be studied
- Long term monitoring of water level is essential to any future impact of camp pumping in this zone

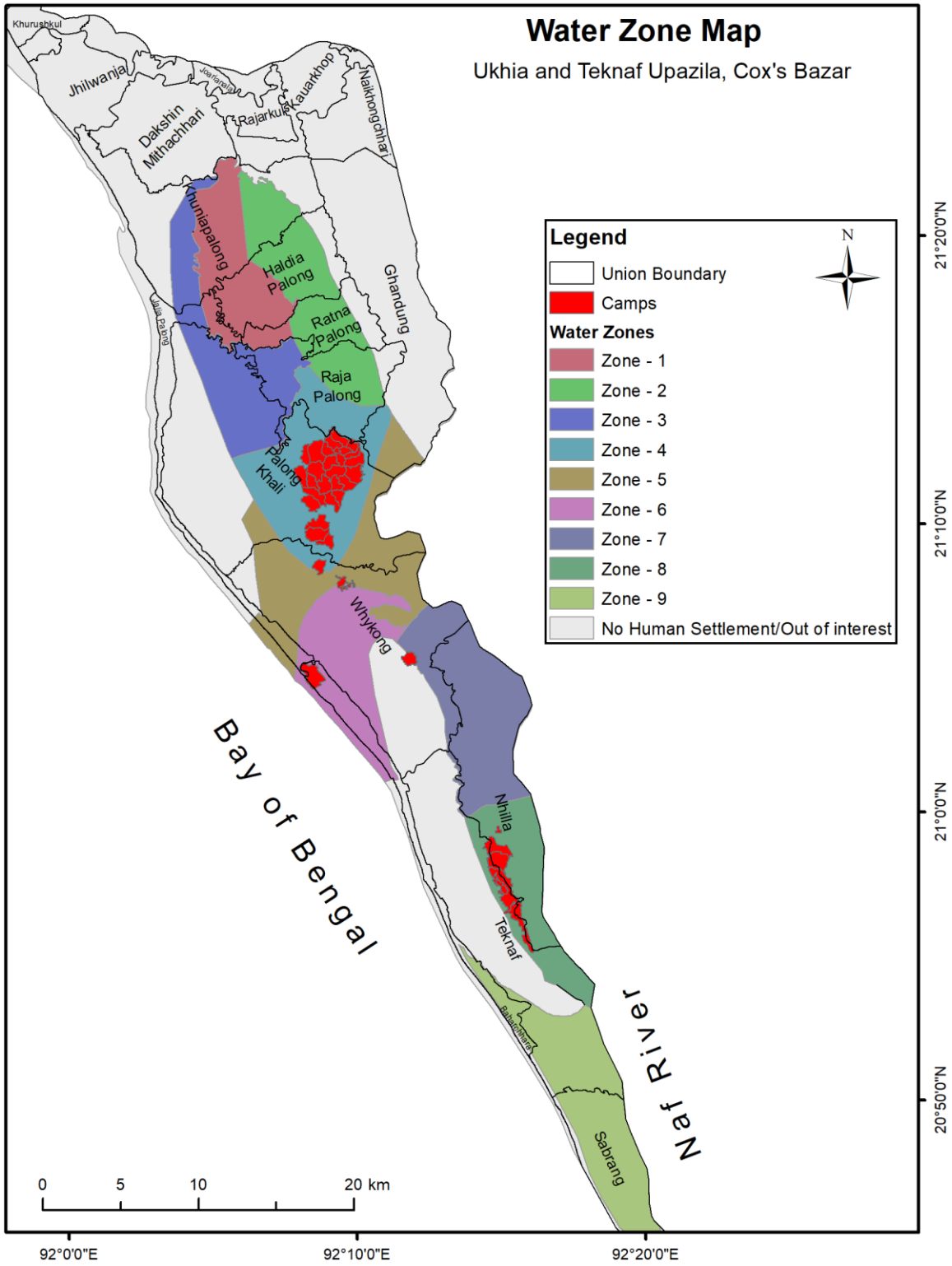
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-2

WATER ZONES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Ukhia and Teknaf Upazila, Cox's Bazar
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Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER ZONE-2

Geographic Location

Khunia Palong Union

- Dariar Dighi (Northern part)
- Dhechua Palong

Haldia Palong Union

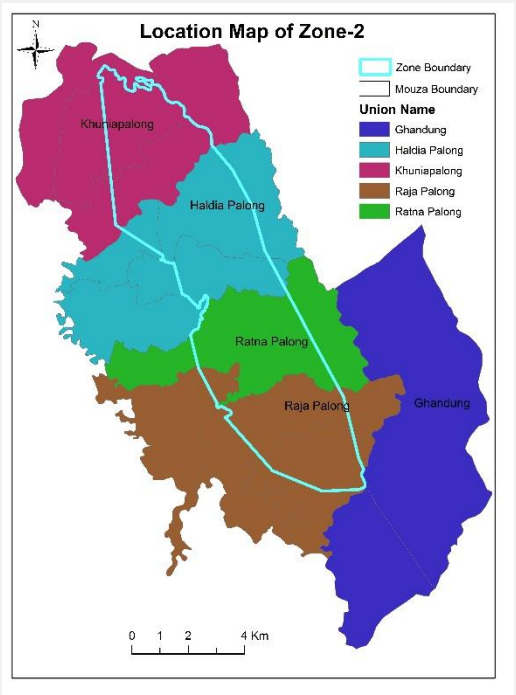
- Haldia Palong (central part)
- Paglir beel

Ratna Palong Union

- Ratna Palong Mouza

Raja Palong Union

- Uhala Palong Mouza (Southern part)
- Ukhiya mouza



Aquifer Description

Dupi Tila Aquifer

- **Depth**: Surface to about 250m
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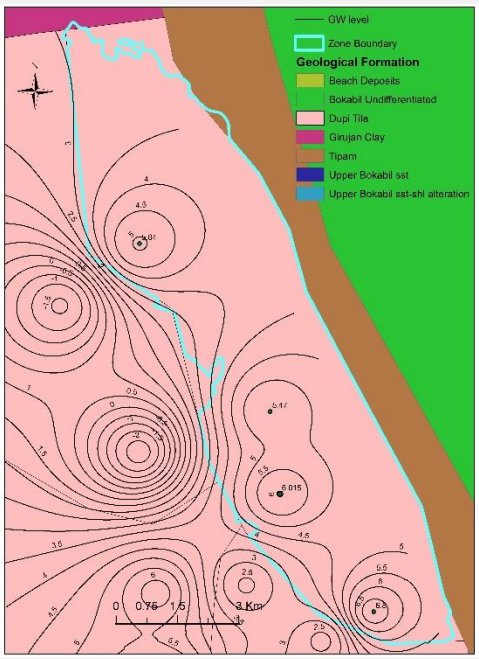
Tipam Aquifer

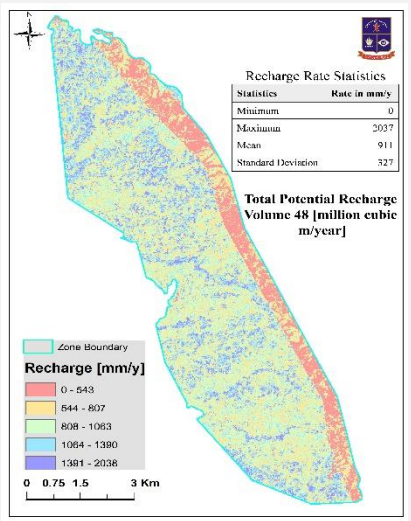
- **Depth**: Inferred below 350m
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity



Groundwater Availability and Abstraction

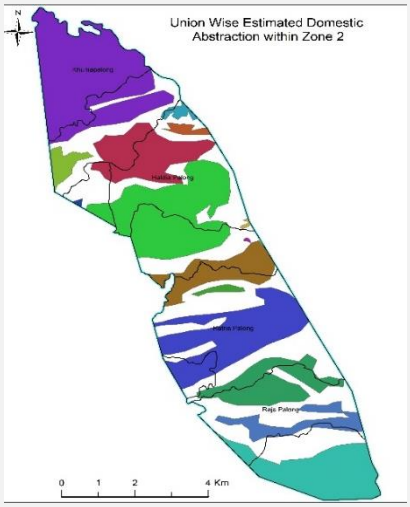
Groundwater Recharge Potential

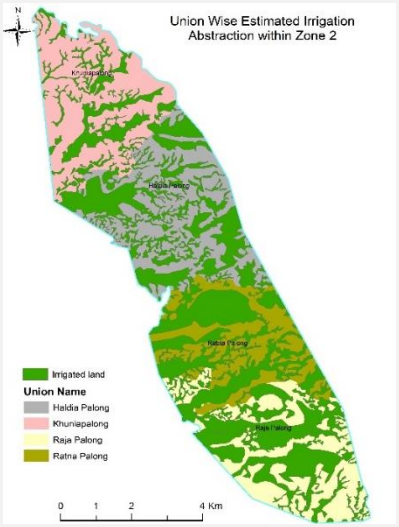
- Potential recharge in Dupi Tila in Zone 1 is **48 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August
- Tipam gets recharged in hilly region in the eastern part of the zone-2 where it is exposed. Exact recharge volume for Tipam in zone-2 is difficult to estimate.



Groundwater Abstraction

- Estimated domestic consumption is about **3.3 Mm^3/yr** considering 50 litre/person/day
- Estimated irrigation consumption **17.5 Mm^3/yr** considering 0.75m water use per unit irrigation area per year



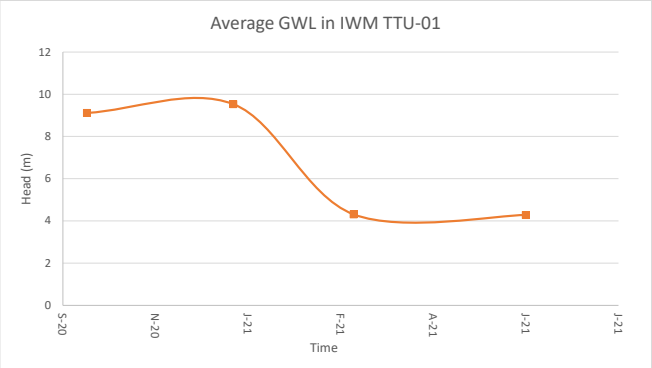


**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

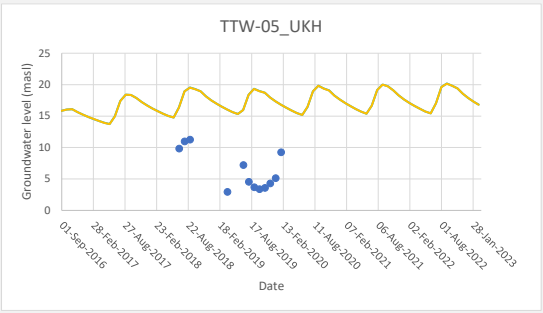
Seasonal Fluctuation

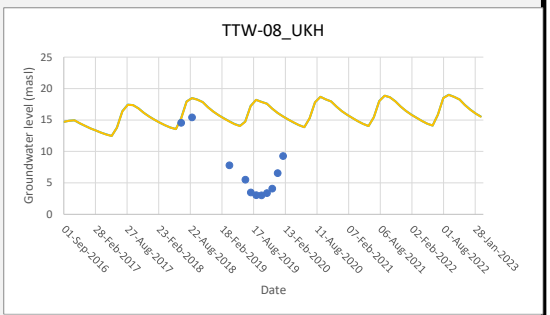
- In this zone its difficult to understand the groundwater level despite having 04 nos Monitoring well.
- In the lower part seasonal fluctuation is reported to be a few meter by local people
- From manual reading in IWM TTU-01 is showing a trend of declining water level but lack of authenticate data does not allow to comment



Groundwater Level Trend

- Dupi Tila formation generally has good permeability, recovered the ~6-7 m in monsoon period
- Manual reading was incorporated with model projection which showing higher vertical fluctuation in the graph.
- Highly recommended to starting effective monitoring in this zone to validate the projection





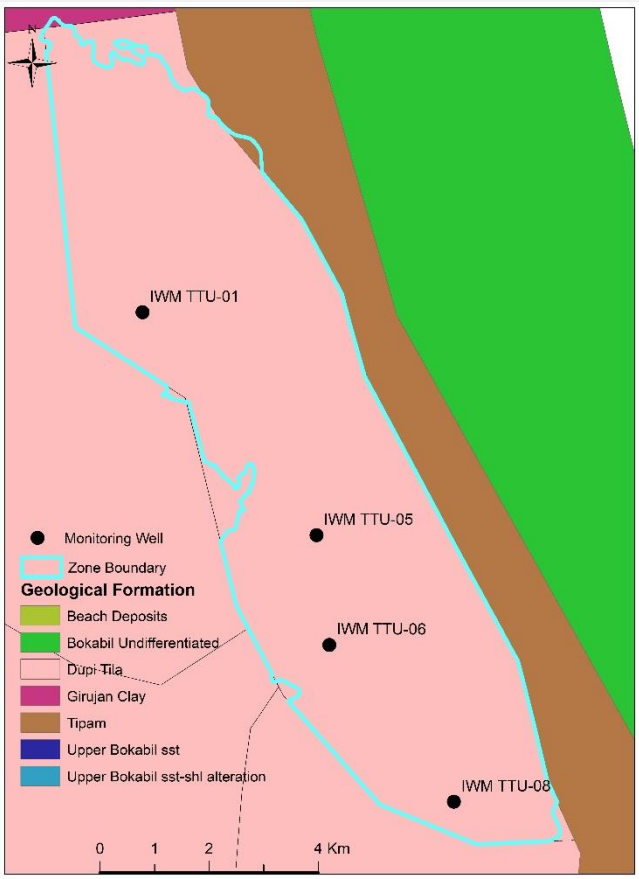
Solid line is model predicted head and dots are observed head in the IWM_TTW-05, IWM_TTW-08

Groundwater Quality

The following water quality results are based monthly water quality analysis in two wells (**IWM TTU-01 IWM TTU-05**, **IWM TTU-06** and **IWM TTU-08**) for a period of 9 months. Reported well depths are in the range of 120 to 240 m

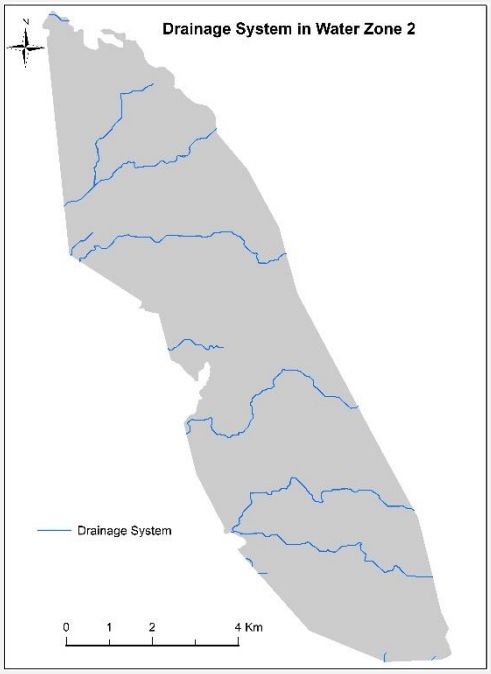
- **Salinity:** Fresh drinking water
- **Water type:** Na/Mg-bicarbonate
- **Nitrate:** Higher then standard on **IWM TTU-06 about 4.31 mg/l in month of October'19**
- **Fluoride:** Below Bangladesh standard
- **Iron:** Exceeding the standard in **IWM TTU-08** found 12.29 mg/l in October'19, need to continue water quality analysis
- **Microbial Contamination:** There is no trace of E-coli in the monitoring wells

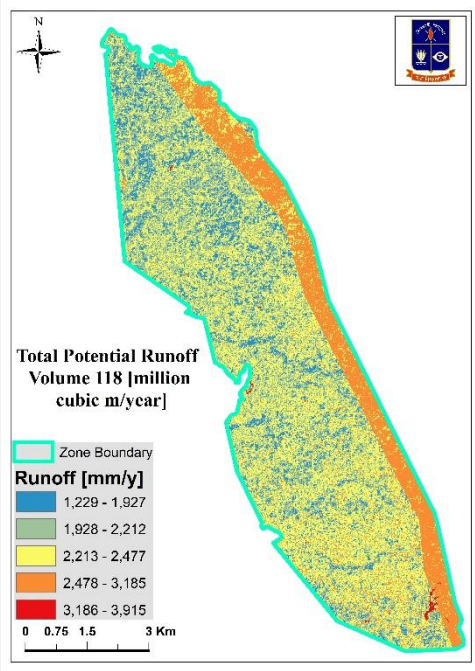
Parameter	Bangladesh Standard for Drinking Water ECR'97	No sample	Max	Min
pH	6.5-8.5	4	8.13	5.56
Temp (˚C)	20-30˚C	4	28.1	26.1
EC (uS/cm)	N/A	4	420	166
Fe mg/l	0.3-1.0mg/l	4	12.29	0.04
E-Coli	0 cfu	4	Nil	
Mn	0.1 mg/l	4	0.98	-0.05
Fl-	1.0 mg/l	4	0.23	0
NO3-	10 mg/l	4	4.31	0



Surface Water Potentiality

- Densely populated and cultivated land is the main surficial characteristics of this zone
- Some seasonal/ intermittent local stream develops in wet season
- Almost entire zone-2 is low in relief except the eastern part
- High runoff generates along the eastern margin where Girjuan Clay is exposed
- Annual surface runoff is 118 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage





Summary and Recommendation

Summary

- Groundwater potentiality is moderately good
- Surface water potentiality is low
- Estimated annual water demand is around 20.8 Mm^3/yr where estimated annual recharge within Dupi Tila is ~48Mm^3/yr
- Sharp declination of groundwater level may be due to high irrigation pumping and low yield and transmissivity of the aquifer
- Camp pumping is likely have no influence in zone so far
- Water quality is good for drinking purpose

Challenges and Issues

- Shallow domestic wells get defunct during irrigation season
- Water scarcity is huge in this zone as potential recharge is lower then demand
- Water quality (Iron and Nitrate) could be a problem in scattered places under zone-2

Overall Recommendation

- Groundwater should not be the solo source of water in this zone-2
- Tara-pump can be used for shallow hand tubewells
- Deeper wells (>150 m) can be considered for domestic supply
- Required a effective irrigation water management plan in zone-2

Summary and Recommendation

Uncertainties and Further Activities

- There are some uncertainties in this Zone
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
- Required to revive piezometers for effective monitoring
- Monitoring of both groundwater level and monthly water quality for at least a year
- Couple of capacity building program on proper groundwater management with stakeholders for sustainable water supply
- Feasibility for artificial recharge in wet period can be studied
- Long term monitoring of water level is essential to any future impact of camp pumping in this zone

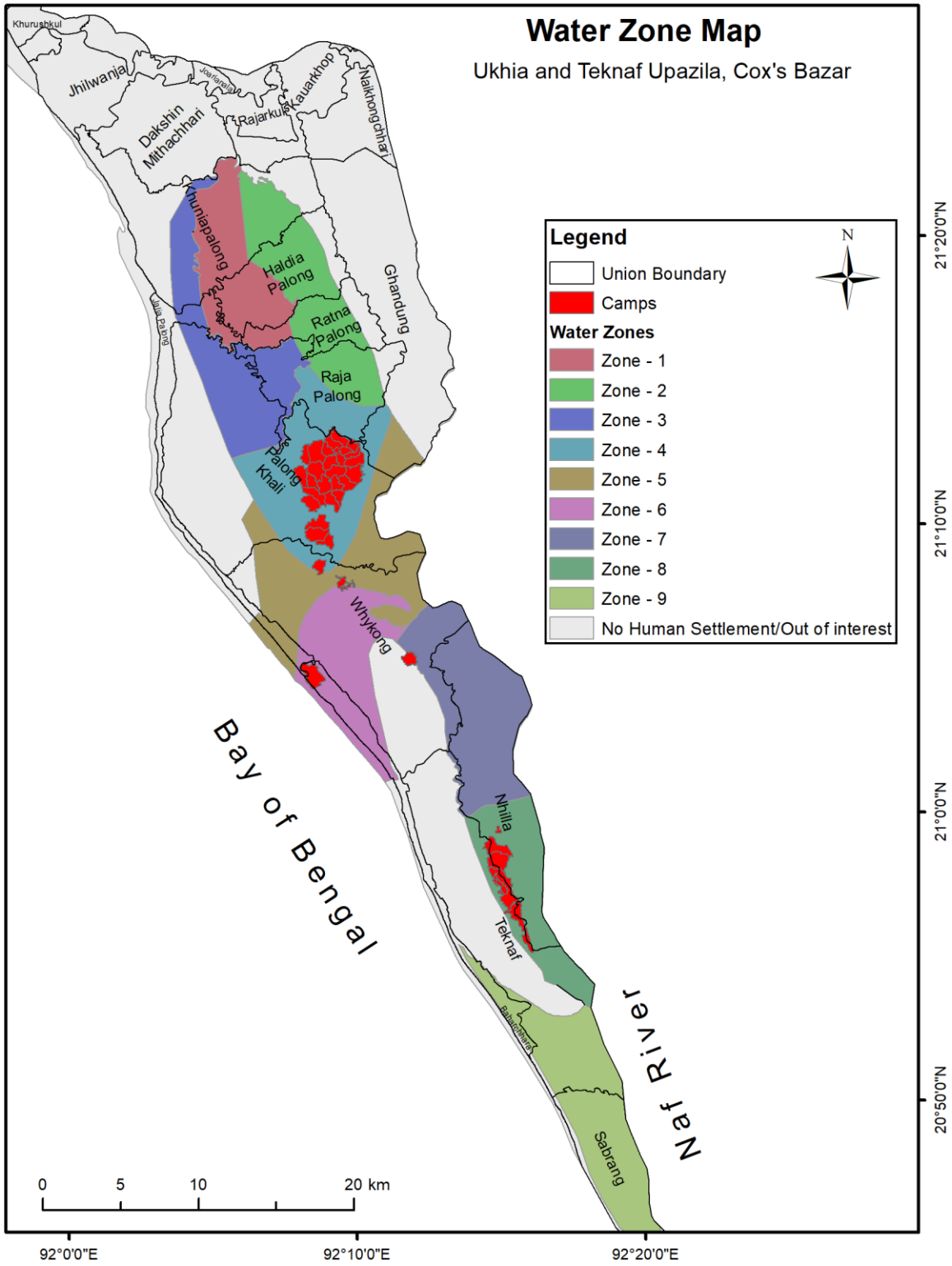
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-3

WATER ZONES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No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER ZONE-3

Geographic Location

Khunia Palong Union

- Khunia Palong Mouza (Nothern part)
- Jungle Doha Palong Mouza
- Jungle Goalia Palong Mouza

Jalia Palong Union

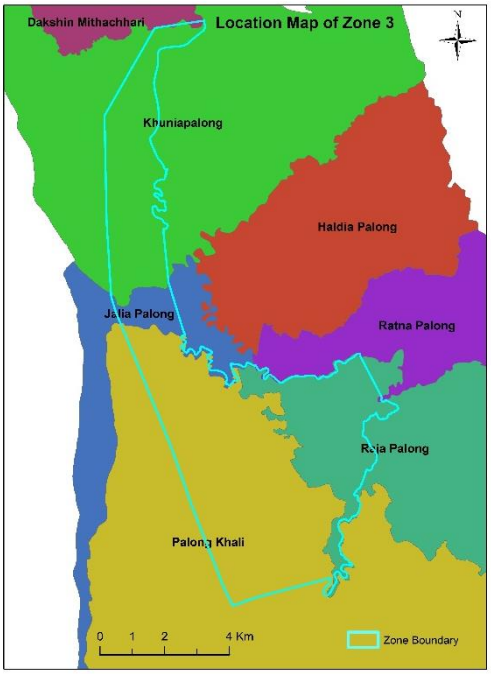
- Jalia Palong Mouza in center

Raja Palong Union

- Raja Palong Mouza (Western Part)

Paling Khali Union

- Palong khali Mouza (Southern Part)



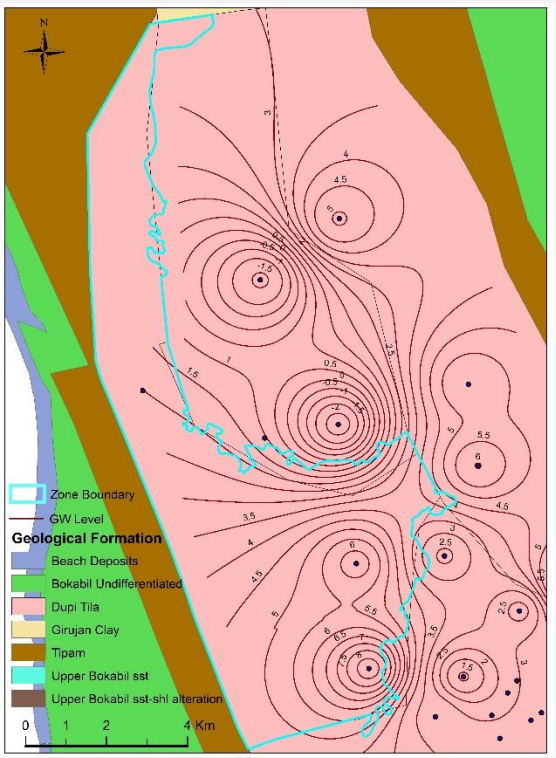
Aquifer Description

Dupi Tila Aquifer

- **Depth**: Surface to about 250m
- **Type**: Unconfined to semi-confined
- **Nature**: Highly heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively low transmissivity and low storativity in this zone

Tipam Aquifer

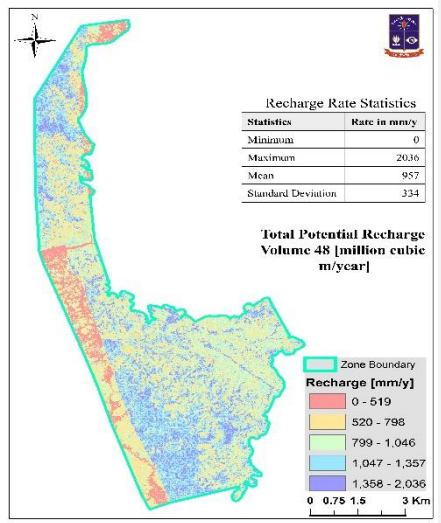
- **Depth**: Inferred below 350m
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity



Groundwater Availability and Abstraction

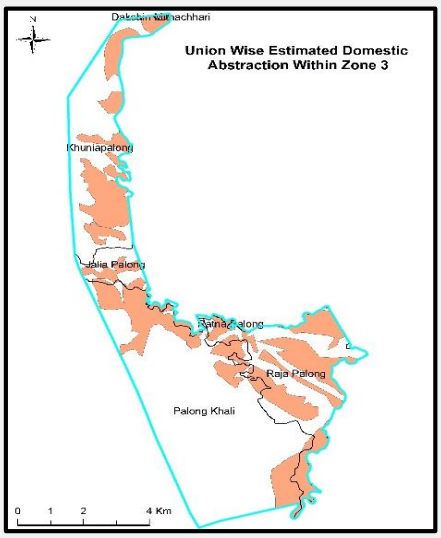
Groundwater Recharge Potential

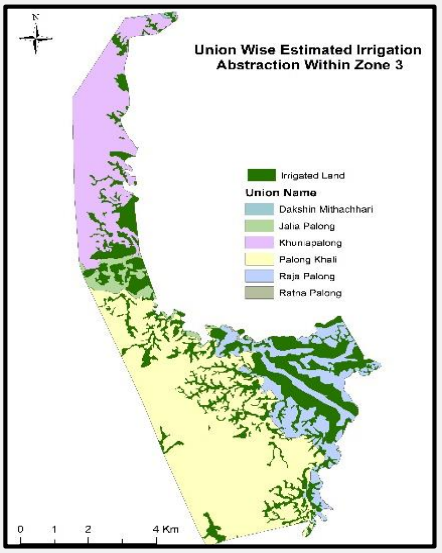
- Potential recharge in Dupi Tila in Zone 3 is 48 [Mm^3/y]*
- Recharge time May to September
- Highest in June to August
- Tipam gets recharged in hilly region outside zone-3 where it is exposed. Exact recharge volume for Tipam in zone-3 is difficult to estimate.



Groundwater Abstraction

- Estimated domestic consumption 3.5 Mm^3/yr considering 50 litre/person/day
- Estimated irrigation consumption 9.5 Mm^3/yr considering 0.75m water use per unit irrigation area per year



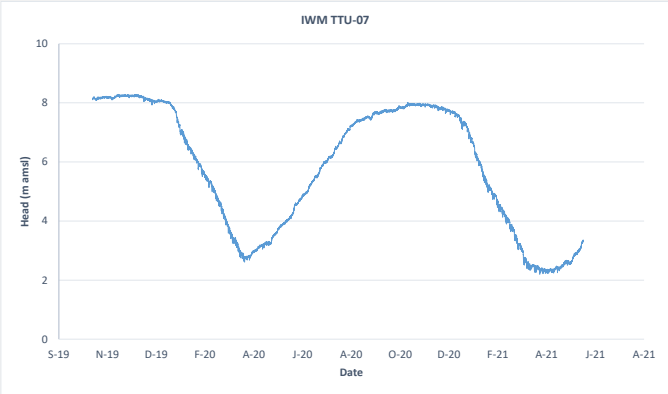


**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

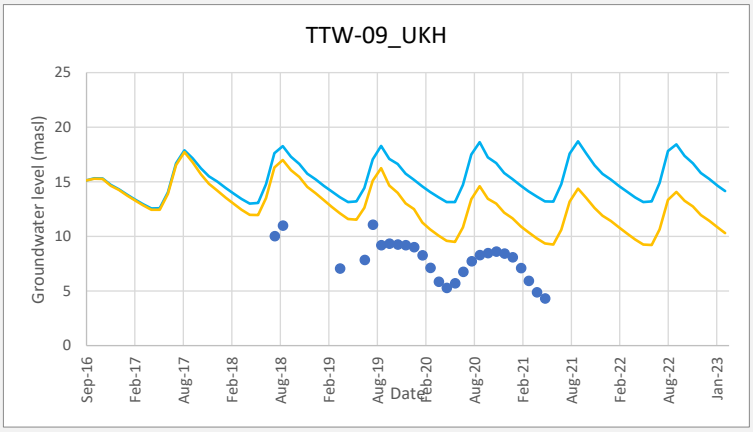
Seasonal Fluctuation

- 4-5 m water level fluctuation in Dupi Tila (at around 150-200 m depth)
- Because potential recharge > withdrawal groundwater level returns close to land surface even after high seasonal drawdown caused by irrigation pumping
- Unusual seasonal drawdown indicates very low storage and transmissivity of the aquifer; needs to be verified.



Groundwater Level Trend

- From model projection anticipated water level following the trend but not vertical fluctuation
- Dupi Tila formation in zone-3 has good permeability which recovered almost full in monsoon period

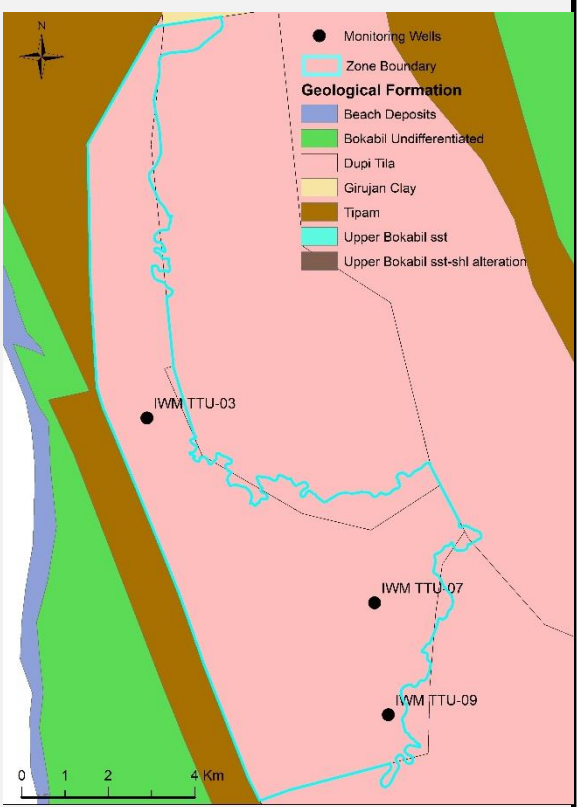


Groundwater Quality

The following water quality results are based monthly water quality analysis in two wells (**IWM TTU-03 IWM TTU-07 and IWM TTU-09**) for a period of 9 months. Reported well depths are in the range of 150 to 220 m

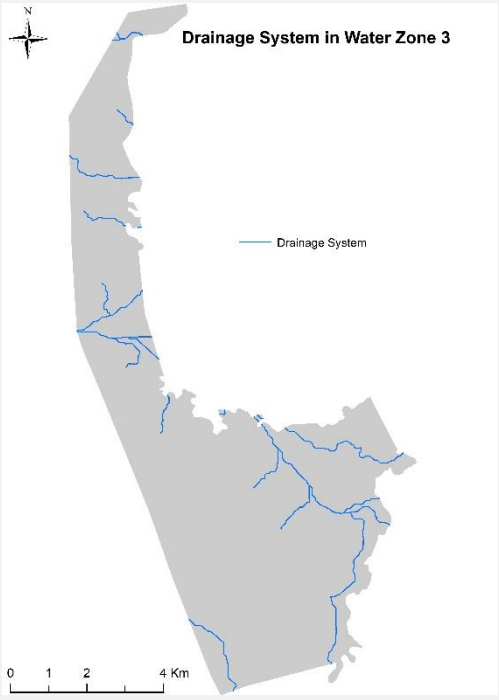
- **Salinity:** Fresh drinking water
- **Water type:** Magnesium Bicarbonate
- **Heavy Metals:** Below Bangladesh Standard for Arsenic and Manganese. Bangladesh Standard throughout the year.
- **Nitrate:** Only one month on IWM TTU-03 (Jan'20) nitrate found higher then the standard (16.78)
- **Fe:** On IWM TTU-09 found higher value in month of July 2019 (5.81)
- **Fluoride:** Below Bangladesh standard
- **Microbial Contamination:** There is no trace of E-coli in monitoring wells

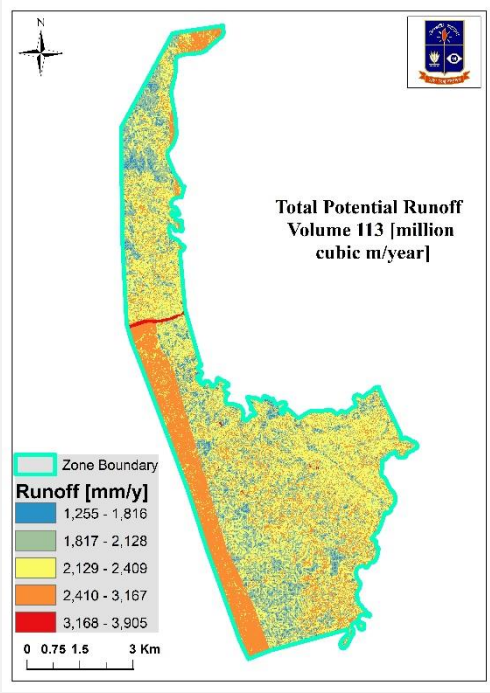
Parameter	Bangladesh Standard for Drinking Water ECR'97	No of samples	Max	Min
pH	6.5-8.5	3	7.97	6.32
Temp (˚C)	20-30˚C	3	27.6	25.8
EC (uS/cm)	N/A	3	320	144
Fe mg/l	0.3-1.0mg/l	3	5.81	0.06
E-Coli	0 cfu	3	Nil	
Mn	0.1 mg/l	3	0.26	0.014
Fl-	1.0 mg/l	3	0.21	0
NO3-	10 mg/l	3	16.78	0.01



Surface Water Potentiality

- Population and cultivation are main surficial characteristics which is progressing along the line of the drainage system of this zone
- Relief is relatively low except the western part
- High runoff generates along the western margin where Girjuan Clay is exposed
- Annual surface runoff is 113 Mm^3
- There are hilly terrain in the western boundary of the Zone, surface water reservoir can be a good source





Summary and Recommendation

Summary

- Groundwater potentiality is moderately good
- Surface water potentiality is low
- Estimated annual water demand is around 13 Mm^3/yr where estimated annual recharge is well higher then demand ~48Mm^3/yr
- Despite high potential recharge groundwater level drops more than 4 m during irrigation season
- Sharp declination of groundwater level may be due to high irrigation pumping and low yield and transmissivity of the aquifer
- Camp pumping is likely have no influence in zone so far
- Water quality is good for drinking purpose

Challenges and Issues

- Shallow domestic wells get defunct during irrigation season
- Many shallow irrigation well also become defunct due to high water table depth

Overall Recommendation

- Tara-pump can be used for shallow hand tubewells
- Deeper wells (>150 m) can be considered for domestic supply
- Irrigation pumping should be kept shallow despite high seasonal water table. Pump technology that works under deeper depth should be considered
- Increase irrigation water efficiency

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
- Monitoring of both groundwater level and monthly water quality for at least a year
- Couple of capacity building program on proper groundwater management with stakeholders for sustainable water supply
- Feasibility for artificial recharge in wet period can be studied
- Long term monitoring of water level is essential to any future impact of camp pumping in this zone

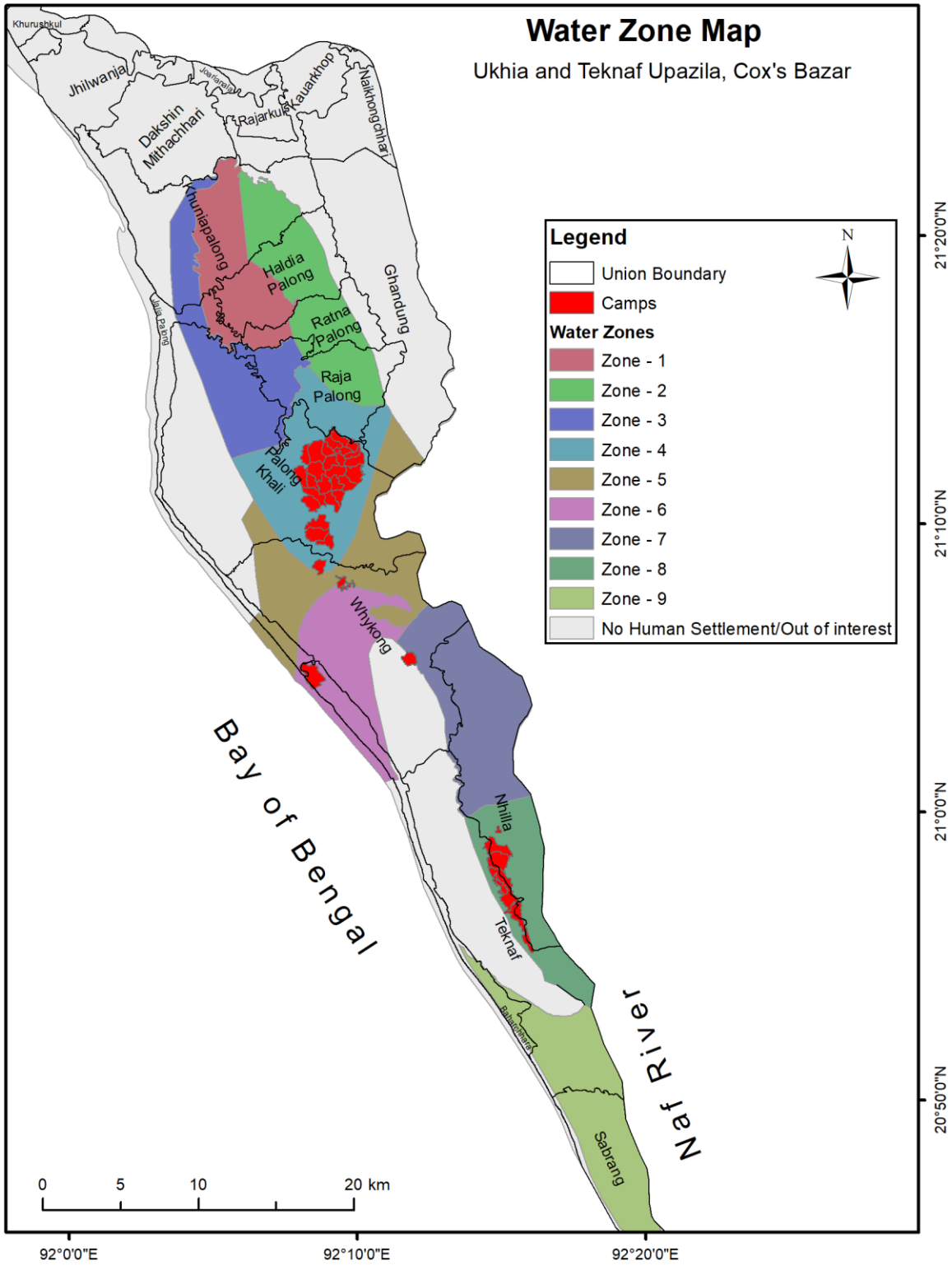
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-4

WATER ZONES


Water Zone Map
Ukhia and Teknaf Upazila, Cox's Bazar
Legend
Union Boundary
Camps
Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

Water Zone-4

Geographic Location

Raja Palong Union

- Raja palong union in the northern part

Ghandum Union

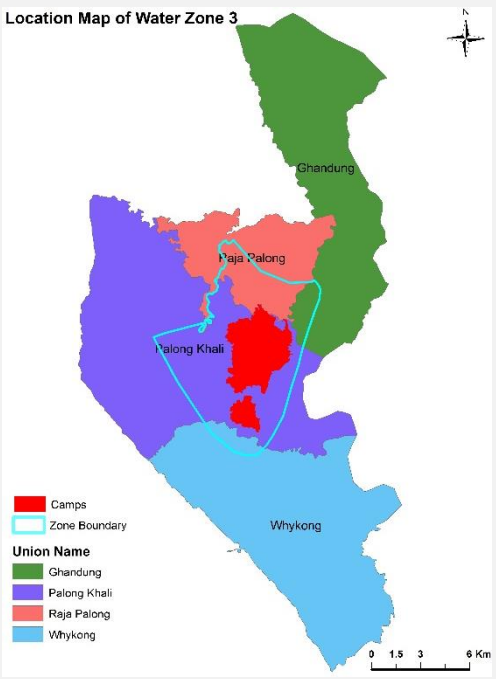
- Ghumdhum in eastern part

Whykhong Union

- Whykhong in southern corner of the zone

Palong khali Union

- Palong khali in center part of the zone, including mega camp



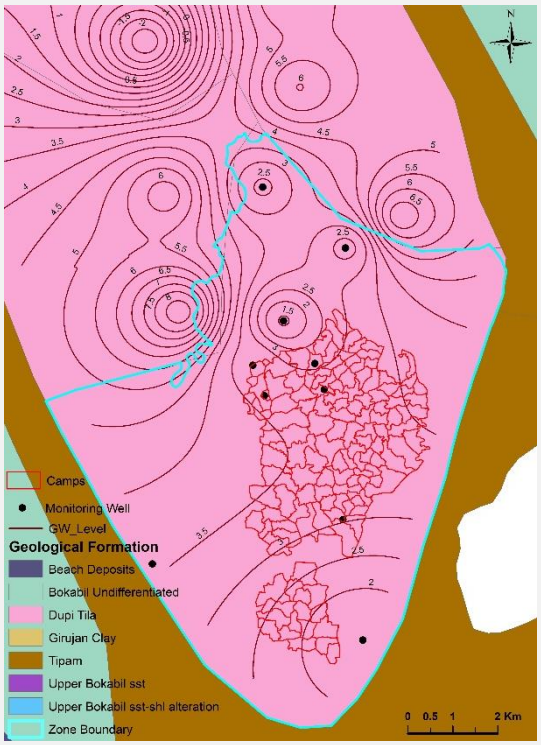
Aquifer Description

Dupi Tila Aquifer

- **Depth**: Surface to about 250m
- **Type**: Unconfined to semi-confined
- **Nature**: Highly heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; though some parameters are known from camp pump tests but not adequate to declare for entire zone-4

Tipam Aquifer

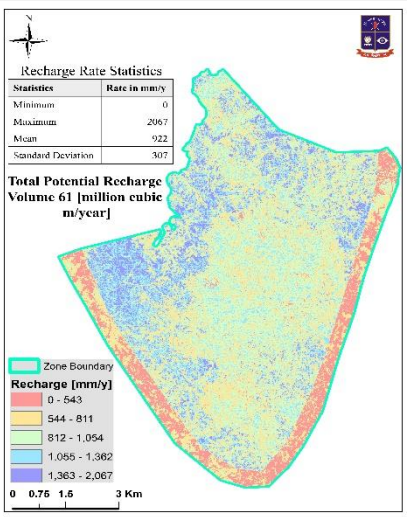
- **Depth**: Inferred below 350m
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity



Groundwater Availability and Abstraction

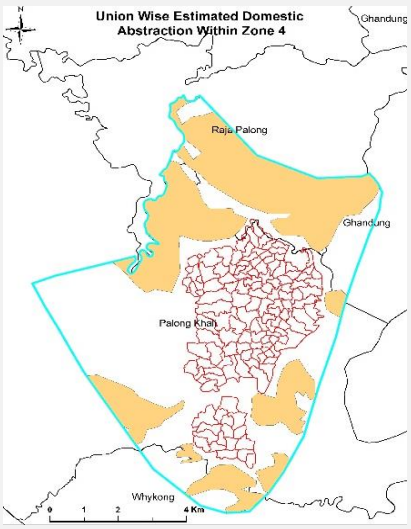
Groundwater Recharge Potential

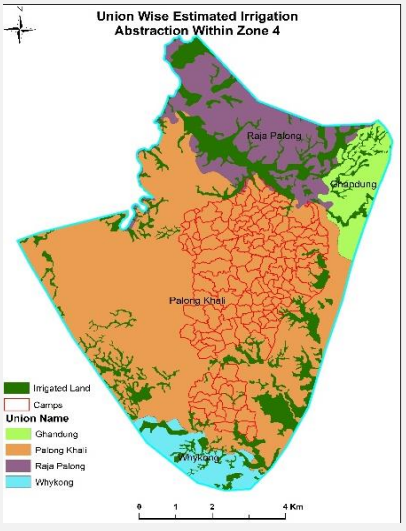
- Potential recharge in Dupi Tila in Zone 4 is **61 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August
- Tipam gets recharged in hilly region outside of zone-4 where it is exposed.



Groundwater Abstraction

- Estimated domestic consumption is 2.8 Mm^3/yr considering 50 litre/person/day
- Camp demand is around 5.8 Mm^3/yr
- Estimated irrigation consumption 7.78 Mm^3/yr considering 0.75m water use per unit irrigation area per year



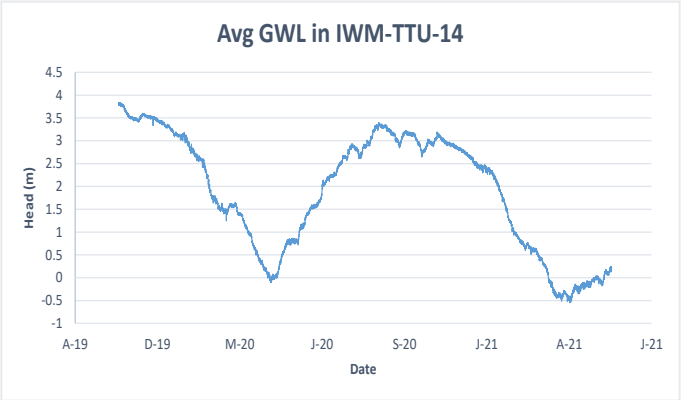


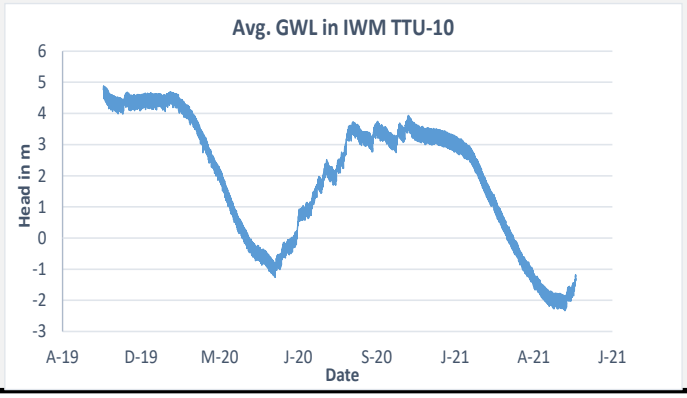
**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

Seasonal Fluctuation

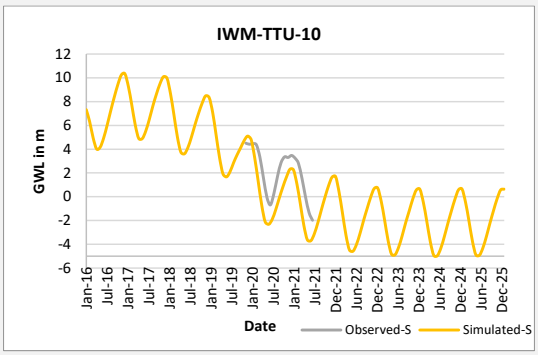
- In this zone its difficult to understand the groundwater level despite having 04 nos Monitoring well.
- In the lower part seasonal fluctuation is reported to be a few meter by local people
- From manual reading in IWM TTU-01 is showing a trend of water level but lack of authenticate data does not allow to comment

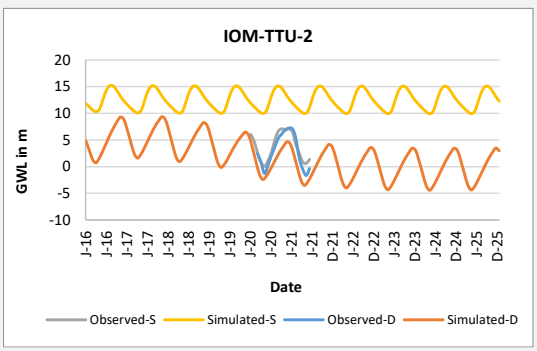




Groundwater Level Trend

- Dupi Tila formation in zone-2 has good permeability which recovered almost full in monsoon period from previous model
- Manual reading was incorporated with model projection which showing higher vertical fluctuation in the graph.
- Highly recommended to starting effective monitoring in this zone to validate the projection



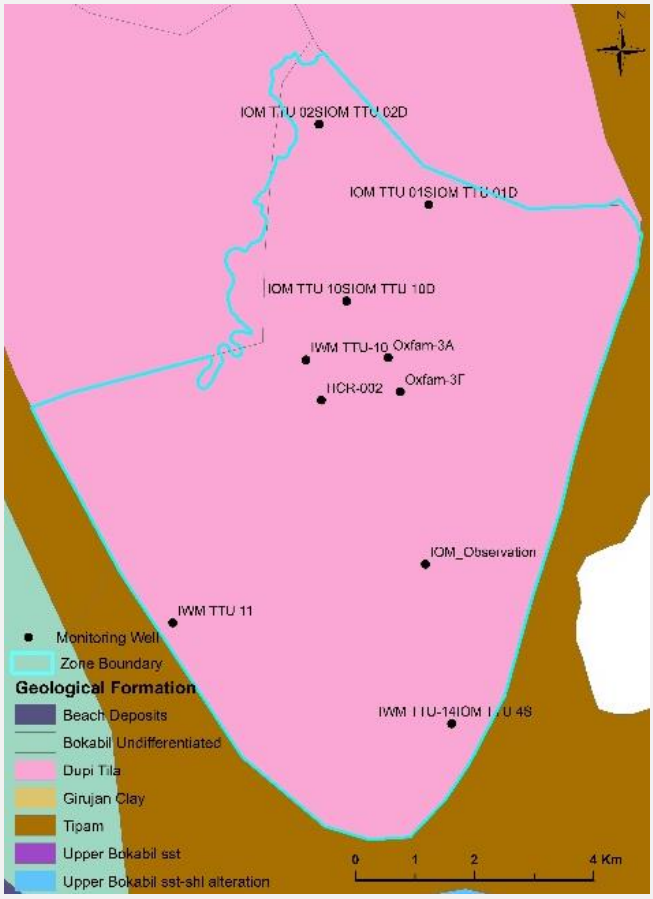


Groundwater Quality

The following water quality results are based monthly water quality analysis in two wells (**IWM TTU-10 IWM TTU-11**, **Oxfam-3A** and **Oxfam-3F**) for a period of 9 months. Reported well depths are in the range of 175 to 240 m

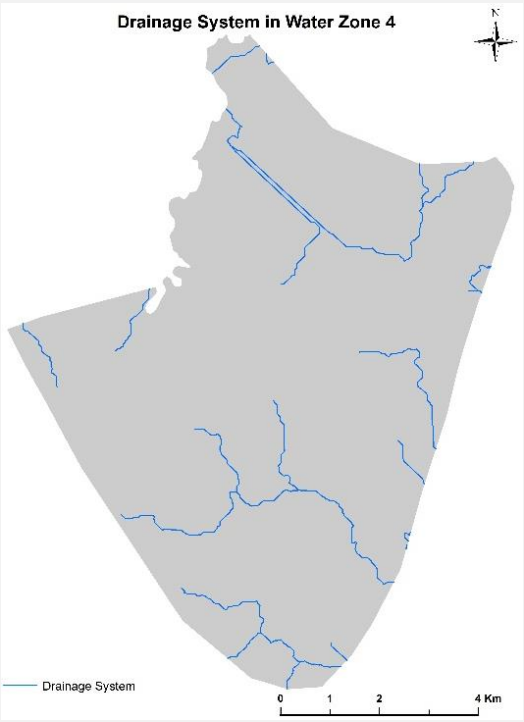
- **Salinity:** Fresh drinking water
- **Water type:** Mg-bicarbonate
- **Nitrate:** Higher then standard on **IWM TTU-10 about 11.43 mg/l** in month of **February'20**
- **Fluoride:** Below Bangladesh standard
- **Iron:** Exceeding the standard in **IWM TTU-11** found 2.0 mg/l in September'19
- **Microbial Contamination:** There is no trace of E-coli found in the monitoring wells

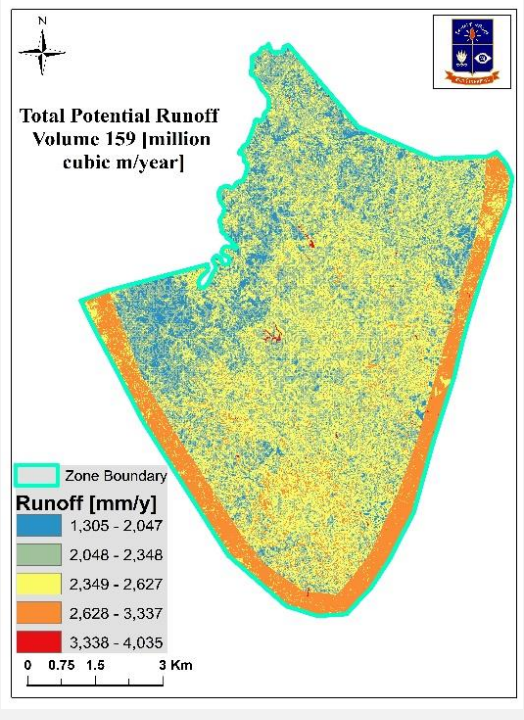
Parameter	Bangladesh Standard for Drinking Water ECR'97	No. sample	Max	Min
pH	6.5-8.5	4	8.2	6.46
Temp (˚C)	20-30˚C	4	29	25.7
EC (uS/cm)	N/A	4	380	168
Fe mg/l	0.3-1.0mg/l	4	2	0.04
E-Coli	0 cfu	4	Nil	
Mn	0.1 mg/l	4	0.57	0.04
Fl-	1.0 mg/l	2	0.38	0.07
NO3-	10 mg/l	4	11.43	0.10



Surface Water Potentiality

- Densely populated by expatriate from Myanmar and shared host community with their cultivated land is the main surficial characteristics of this zone
- Some seasonal/ intermittent local stream develops in wet season
- High runoff generates along the western margin of the zone boundary
- Annual surface runoff is 159 Mm^3





Summary and Recommendation

Summary

- Groundwater potentiality is moderately good
- Surface water potentiality is low
- Estimated annual water demand is around 16 Mm^3/yr where estimated annual recharge is well higher then demand ~61Mm^3/yr
- Despite high potential recharge groundwater level drops 3-5 m during dry season
- Water quality is good for drinking purpose

Challenges and Issues

- Many shallow handpump for domestic purpose get defunct within the period of 2017-2019
- Influx in 2017 made this zone very vulnerable on groundwater depletion
- Massive irrigation is not happening in this zone comparing to other but still its concern for future sustainable water management in this zone

Overall Recommendation

- Tara-pump can be used for shallow hand tubewells
- Deeper wells (>200 m) can be considered for domestic supply
- Integrated management required for camp and host water supply
- Master plan for camp water supply need to be reassessed on the basis of current water table in this zone
- Camp pumping is still solar dominating (8-10hr/day) and should be kept as is to give more time to recover the water level
- Irrigation pumping should be kept shallow despite high seasonal water table
- Pump technology that works under deeper depth should be considered
- Increase irrigation water efficiency

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
    - Proper water resource management
- Monitoring of both groundwater level and monthly water quality for at least one more year
- Incorporate groundwater modelling for future water management
- Incorporate groundwater model simulation to understand water table in the zone
- Couple of capacity building program on proper groundwater management with stakeholders for sustainable water supply
- Feasibility for artificial recharge in wet period can be studied
- Long term monitoring of water level is essential to find the area of influence of camp pumping in this zone

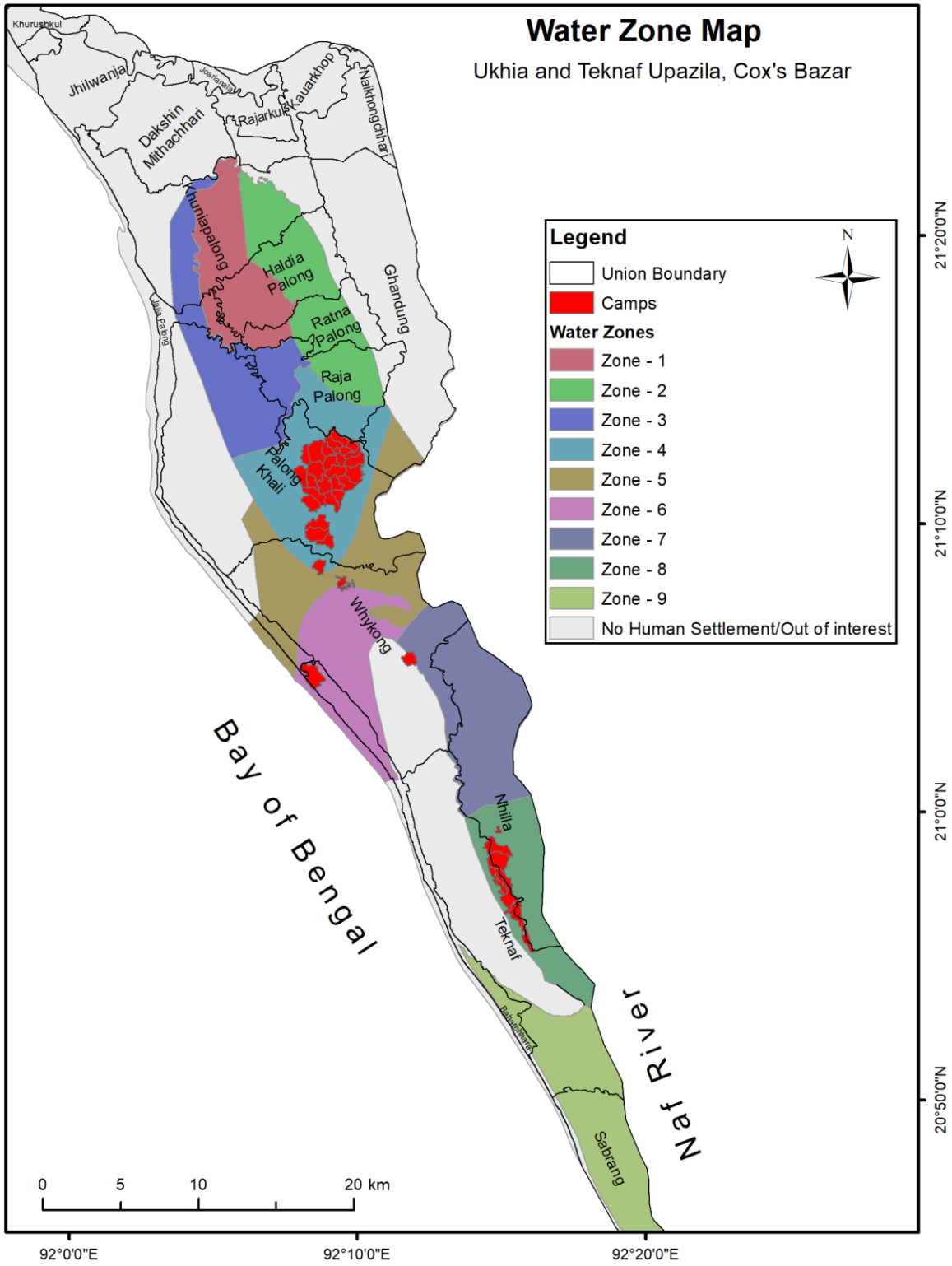
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-5

WATER ZONES


Water Zone Map
Ukhia and Teknaf Upazila, Cox's Bazar
Legend
Union Boundary
Camps
Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER ZONE-5

Geographic Location

Palong khali Union

- Palong khali mouza in north eastern

Jalia Palong Union

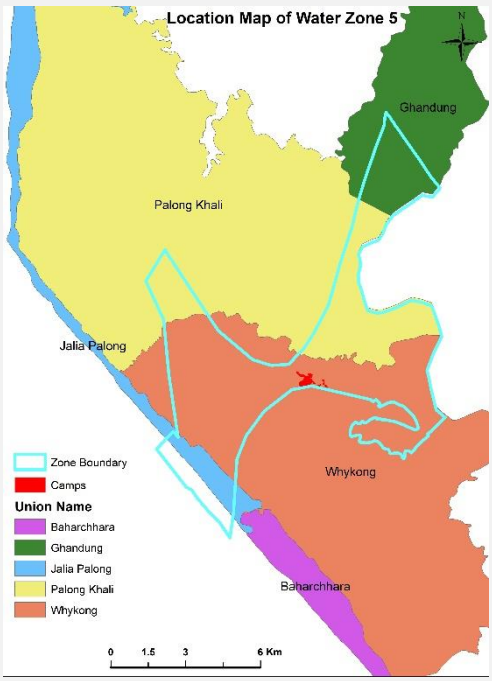
- Inani in the western part

Whykhong Union

- Uttor Nhila in the south

Ghumdhum Union

- Ghumdhum in the north eatern edge



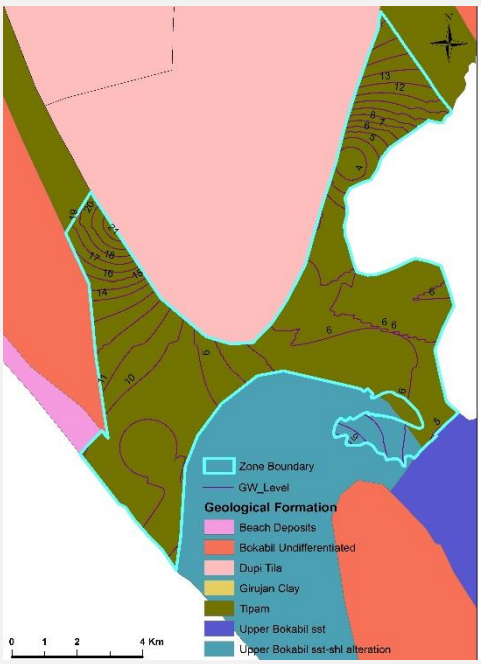
Aquifer Description

Tipam Aquifer

- **Depth**: Surface to 250 m (could be even more yet to explore)
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity

Upper Bokabil Sandstone Aquifer

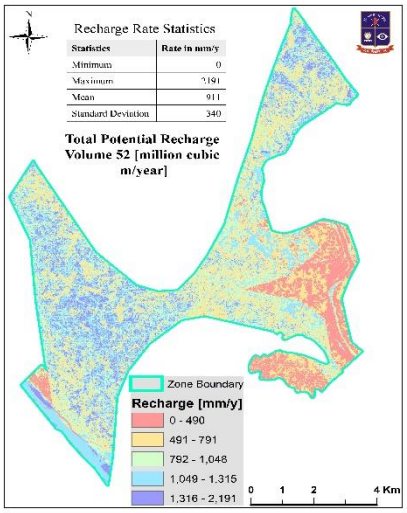
- **Depth**: Inferred 350m (uncertainty lies with depth)
- **Type**: Unconfined to semi-confined
- **Nature**: less heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively very low transmissivity and low storativity in this zone



Groundwater Availability and Abstraction

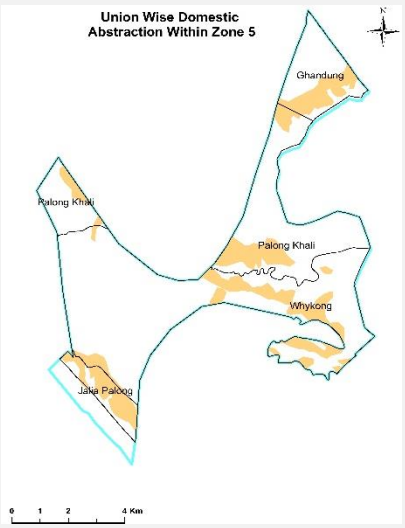
Groundwater Recharge Potential

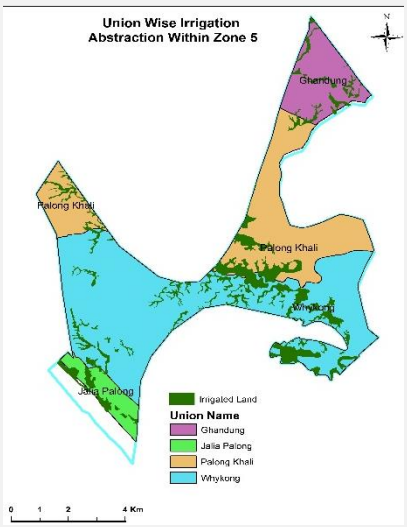
- Potential recharge in Zone 5 is **52 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August
- Exact recharge volume for Tipam in zone-5 is difficult to estimate and its outside of the boundary .



Groundwater Abstraction

- Estimated domestic consumption is 2.6 Mm^3/yr considering 50 litre/person/day
- Estimated irrigation consumption 5.4 Mm^3/yr considering 0.75m water use per unit irrigation area per year



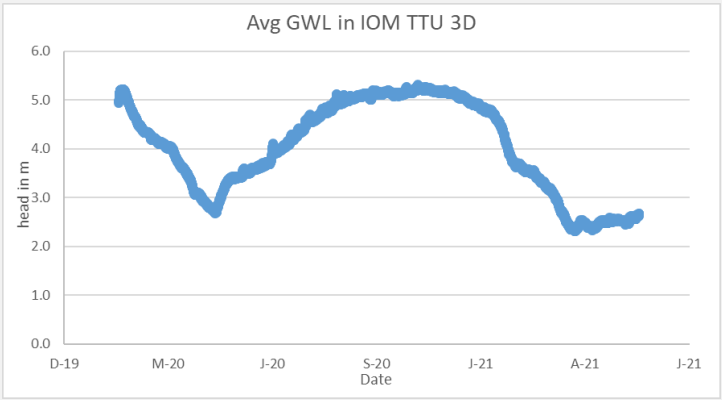


**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

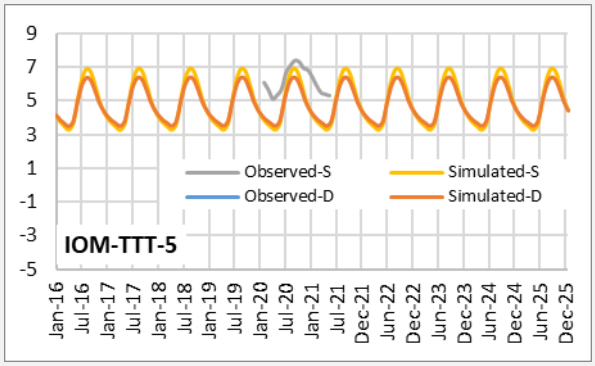
Seasonal Fluctuation

- In this zone its difficult to understand the groundwater level despite having 03 nos Monitoring well on **(IOM TTU-03 S&D), (IOM TTT-05 S&D), (IOM TTU-07 S&D). Couple of Artesian wells are here.**
- Also having slow recovery of about 2-3m water level within long dry period
- Required more manual/auto logger water level data



Groundwater Level Trend

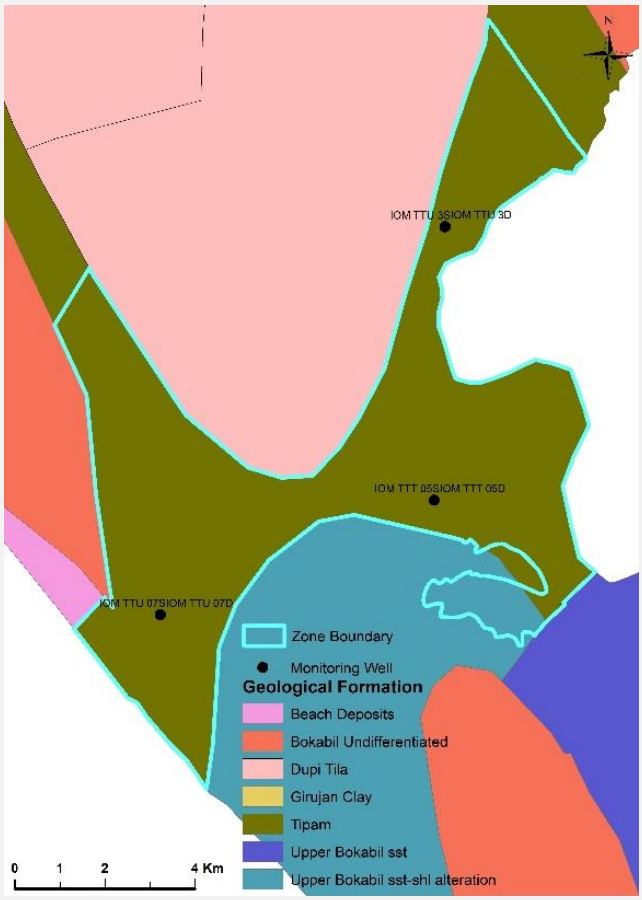
- This Tipam formation is yet to be explore and required to estimate its reserve.
- Model projection and water level data showing a trend here, which need to be verified again
- In Automated WL data head recovery took for quiet a long time



Groundwater Quality

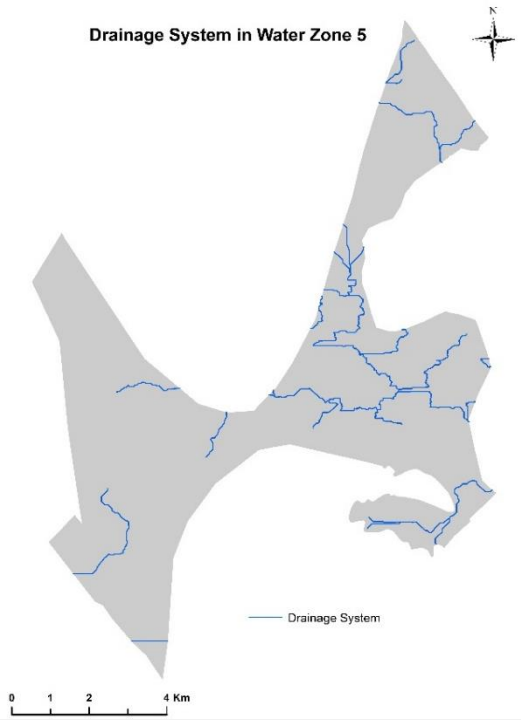
Despite having 3 sets of monitoring wells in different location **(IOM TTU-03 S&D), (IOM TTT-05 S&D), (IOM TTU-07 S&D)** but do not have chemical analysis.

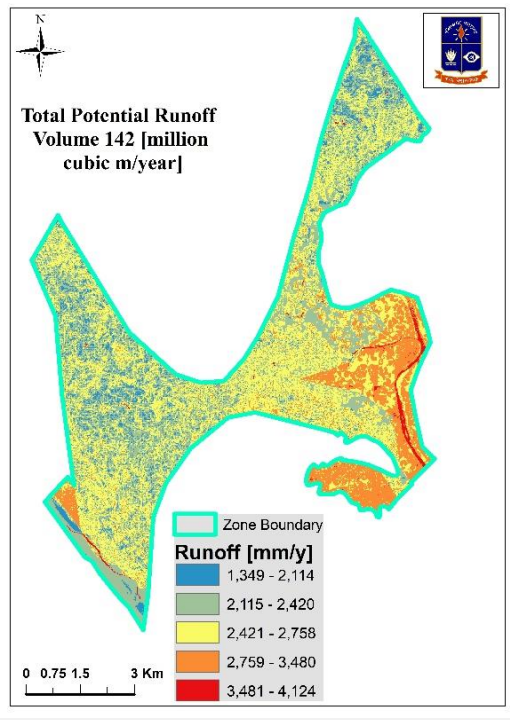
Required some basic parameters analysis to be ascertain on aquifer safety



Surface Water Potentiality

- Less populated and cultivated land is the main surficial characteristics of this zone
- Some seasonal/ intermittent local stream develops in wet season
- Annual surface runoff is 142 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage





Summary and Recommendation

Summary

- Groundwater potentiality is good in zone-5
- Surface water potentiality is low
- Estimated annual water demand is around 8 Mm^3/yr where estimated annual recharge is well higher then demand ~52Mm^3/yr
- Despite high potential recharge groundwater level drops 2~3 m during dry period

Challenges and Issues

- Water quality could be brackish in some places, need to verify
- Water level showing some fluctuation in dry period but unidentical for deeper part of the aquifer (150m+)

Overall Recommendation

- Groundwater can be used but abstraction technology should be assess first where recharge is slow with time
- Tara-pump can be used for shallow hand tubewells
- Deeper wells (>150 m) can be considered for domestic supply
- Irrigation pumping should be kept shallow where seasonal fluctuation is not a problem so far
- Increase irrigation water efficiency

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
    - No water quality data
- Monitoring of both groundwater level and monthly water quality for at least a year
- Feasibility for artificial recharge in wet period can be studied as few artesian wells are here
- Long term monitoring of water level is essential to any future impact of camp pumping in this zone

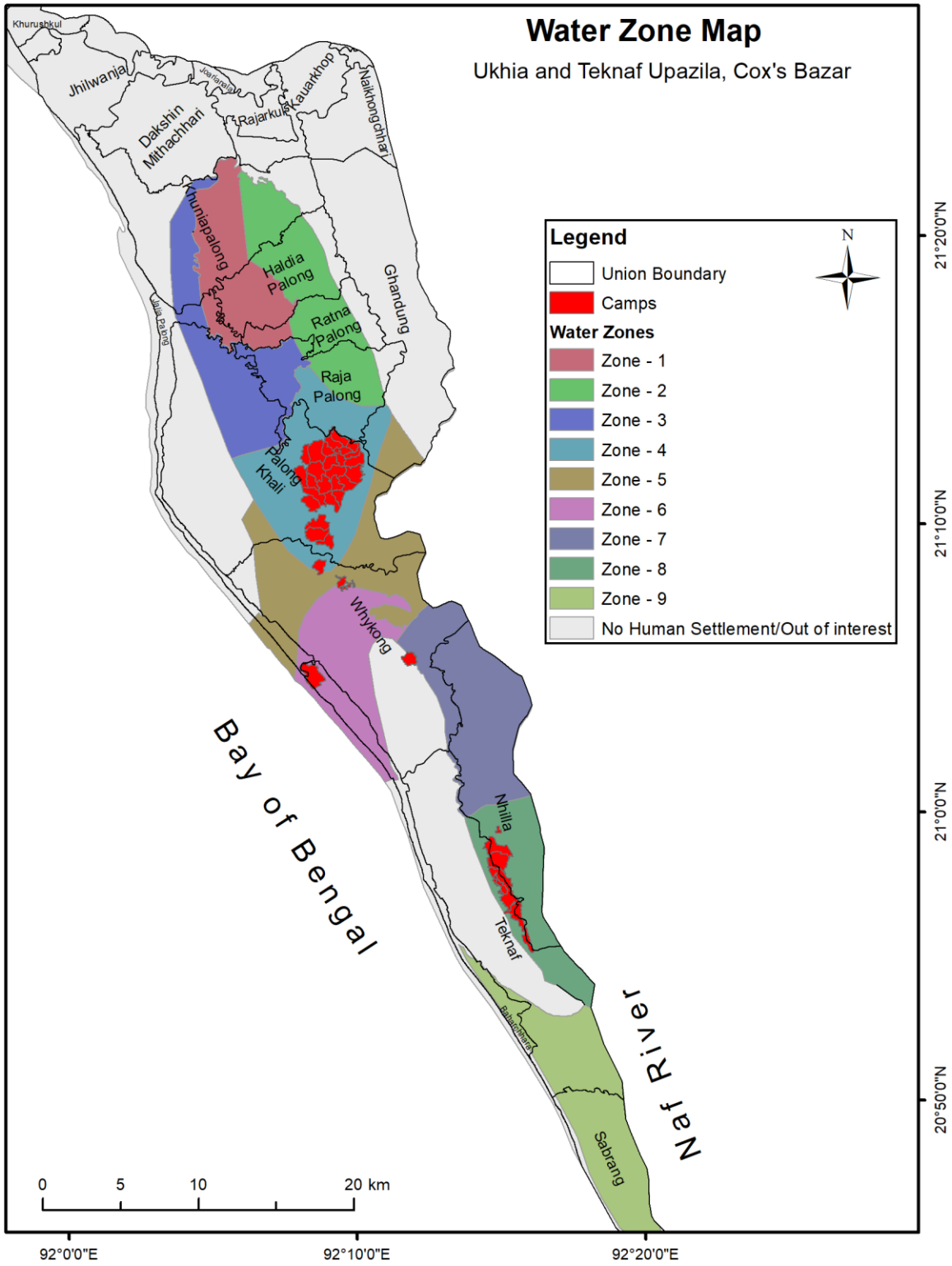
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-6

WATER ZONES


Water Zone Map
Ukhia and Teknaf Upazila, Cox's Bazar
Legend
Union Boundary
Camps
Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER Zone-6

Geographic Location

Jalia Palong Union

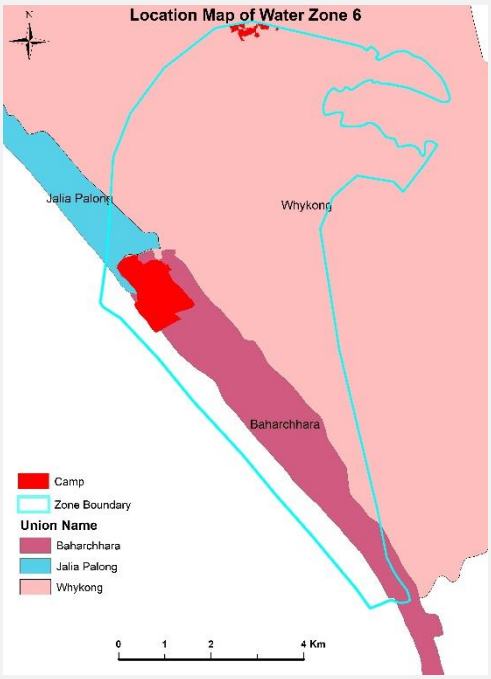
- Shikhali in the western part

Whykhong Union

- Uttor Nhila in the central part

Baharchara Union

- Baharchara mouza in the south western part



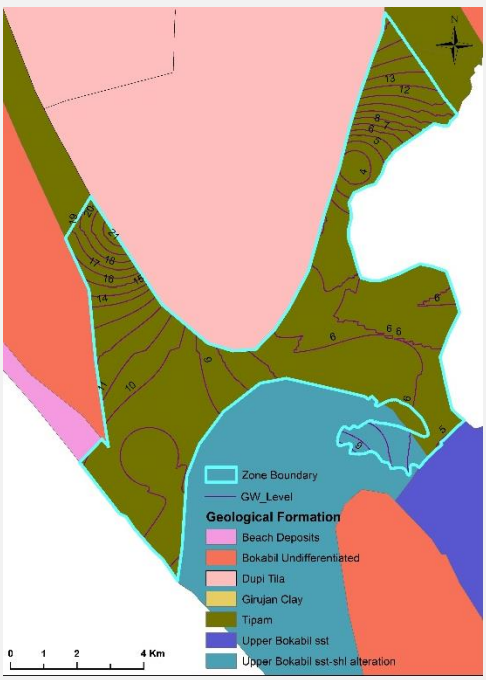
Aquifer Description

Tipam Aquifer

- **Depth**: Surface to 250 m (could be even more yet to explore)
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity

Upper Bokabil Sandstone Aquifer

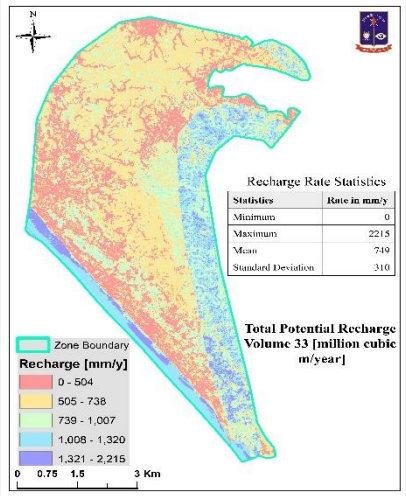
- **Depth**: Inferred 350m (uncertainty lies with depth)
- **Type**: Unconfined to semi-confined
- **Nature**: less heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively very low transmissivity and low storativity in this zone



Groundwater Availability and Abstraction

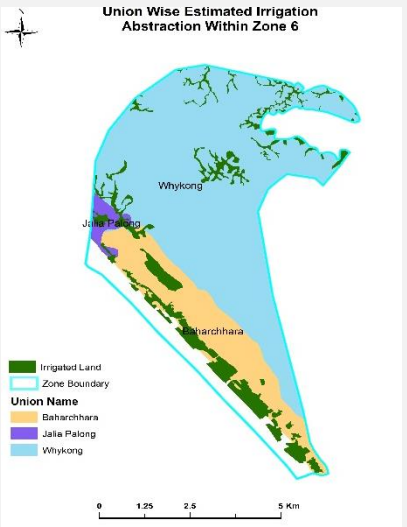
Groundwater Recharge Potential

- Potential recharge in Zone 6 is **33 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August
- Tipam gets recharged in hilly region in the western part of the Zone-6



Groundwater Abstraction

- Estimated domestic consumption in zone-6 is 2.5 Mm^3/yr considering 50 litre/person/day
- Estimated irrigation consumption 3.55 Mm^3/yr considering 0.75m water use per unit irrigation area per year



**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

Seasonal Fluctuation

- There is no information in this zone despite having two auto logger in IWM wells, but wells have been called abundant. No further monitoring.
- Immediate logger replacement required

Groundwater Level Trend

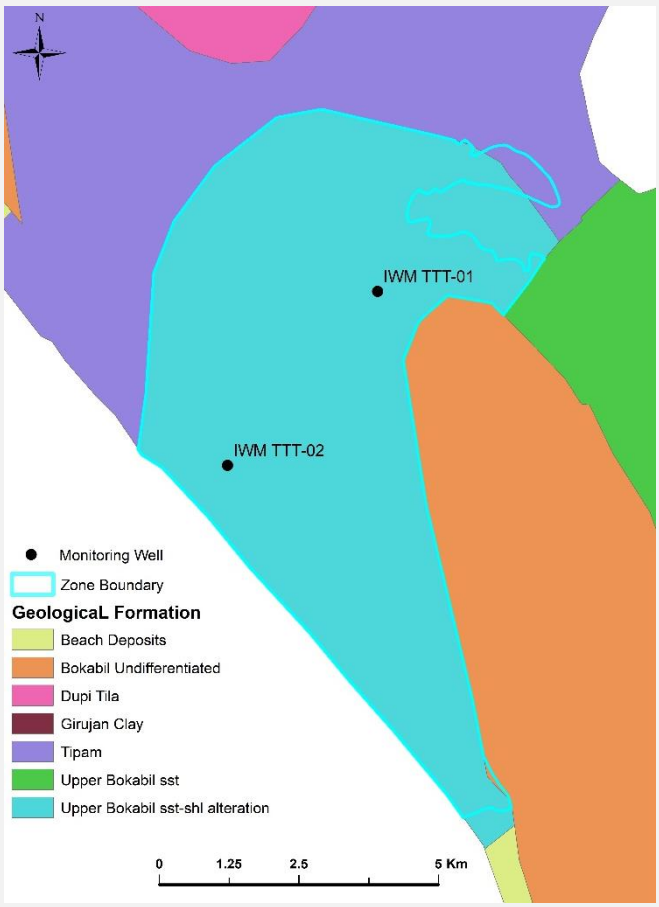
- There is no water level trend due to the gap of continuous monitoring.
- A conclusive summary can be found from model projection

Groundwater Quality

The following water quality results are based monthly water quality analysis in two wells (**IWM TTT-01** and **IWM TTT-02)** for a period of 9 months. Reported well depths are in the range of 76 to 167 m

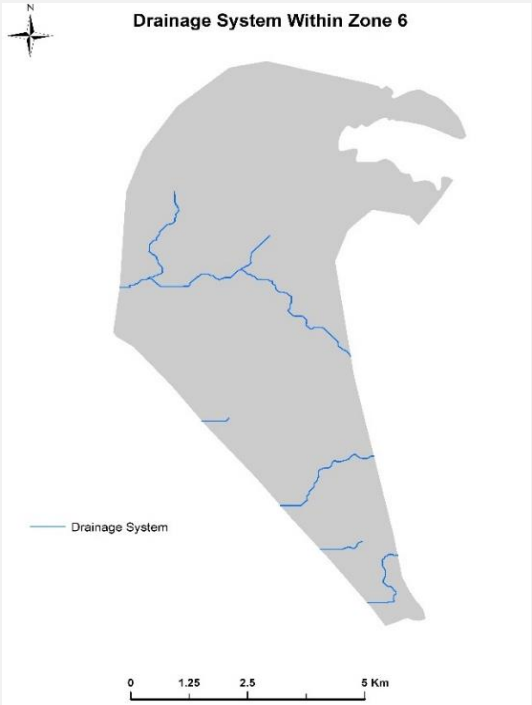
- **Salinity:** Fresh drinking water
- **Water type:** Mg-bicarbonate
- **Nitrate:** Within Bangladesh standard
- **Fluoride:** Within Bangladesh standard
- **Iron:** Within Bangladesh standard
- **Microbial Contamination:** There is no trace of E-coli found in the monitoring wells

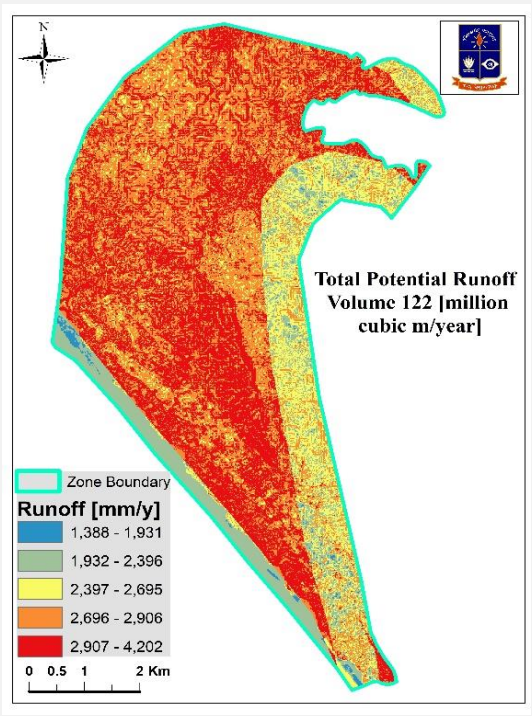
Parameter	Bangladesh Standard for Drinking Water ECR'97	No sample	Max	Min
pH	6.5-8.5	2	8.34	6.58
Temp (˚C)	20-30˚C	2	27.8	25.4
EC (uS/cm)	N/A	2	380	346
Fe mg/l	0.3-1.0mg/l	2	0.75	0.01
E-Coli	0 cfu	2	Nil	
Mn	0.1 mg/l	2	0.2	0.009
Fl-	1.0 mg/l	2	0.2	0
NO3-	10 mg/l	2	2.4	0.02



Surface Water Potentiality

- Less populated and cultivated land in this zone
- Some seasonal/ intermittent local stream develops in wet season
- Annual surface runoff is 122 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage





Summary and Recommendation

Summary

- Groundwater potentiality is good
- Surface water potentiality is low
- Estimated annual water demand is around 6 Mm^3/yr where estimated annual recharge is well higher then demand ~$33Mm^3/yr$
- Having high potential recharge groundwater level should be recorded time to time
- Water quality is good for drinking purpose

Overall Recommendation

- Groundwater can be potentiality is high but groundwater level is unknown.
- Irrigation pumping should be kept shallow for sustainable water management.
- Increase irrigation water efficiency

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No primary data on aquifer parameters
    - No water level data
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
- Required at least three (03) more sets of multi-depth piezometer
- Monitoring of both groundwater level and monthly water quality for at least a year
- Feasibility for artificial recharge in wet period can be studied

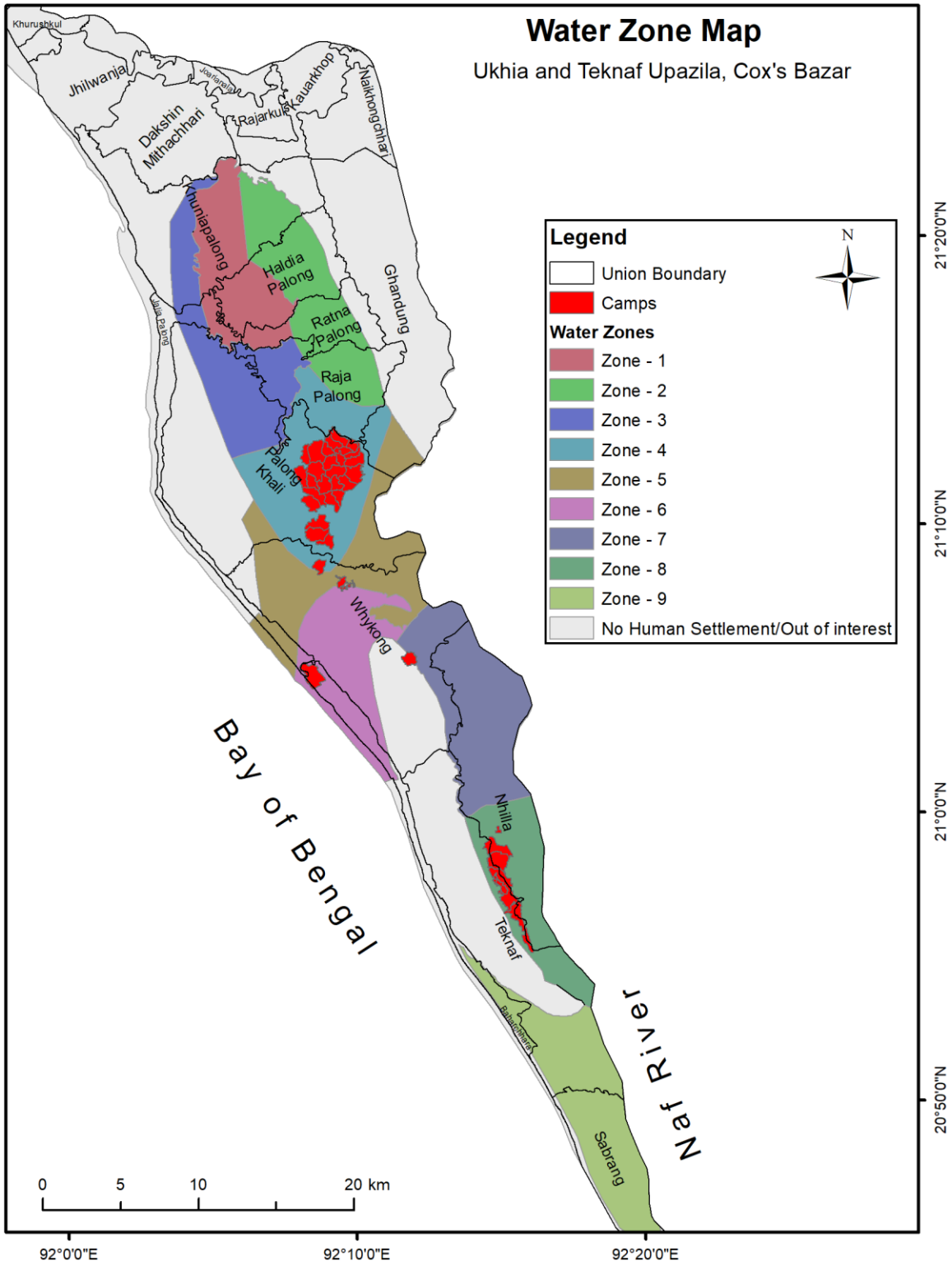
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-7

WATER ZONES


Water Zone Map
Ukhia and Teknaf Upazila, Cox's Bazar
Legend
Union Boundary
Camps
Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER Zone-7

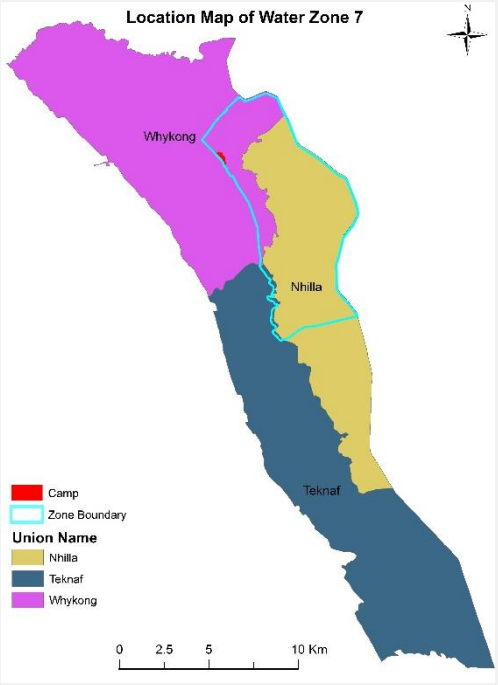
Geographic Location

Whykhong Union

- Uttor Nhila

Nhila Union

- Madhya Nhila (central part)



Aquifer Description

Tipam Aquifer

- **Depth**: Recent sediments to 250 m (could be even more yet to explore)
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity

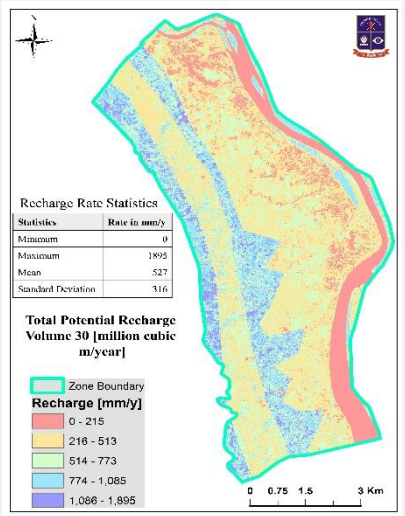
Upper Bokabil Sandstone Aquifer

- **Depth**: uncertainty lies with depth
- **Type**: Unconfined to semi-confined
- **Nature**: less heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively very low transmissivity and low storativity in this zone

Groundwater Availability and Abstraction

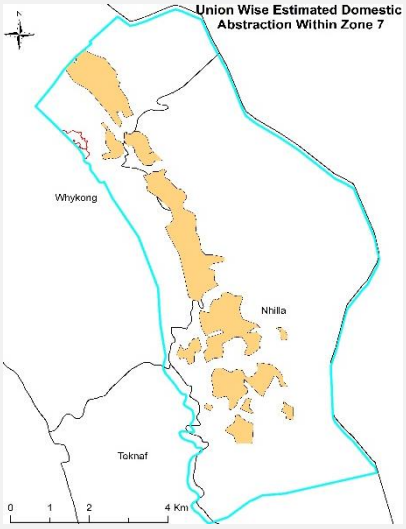
Groundwater Recharge Potential

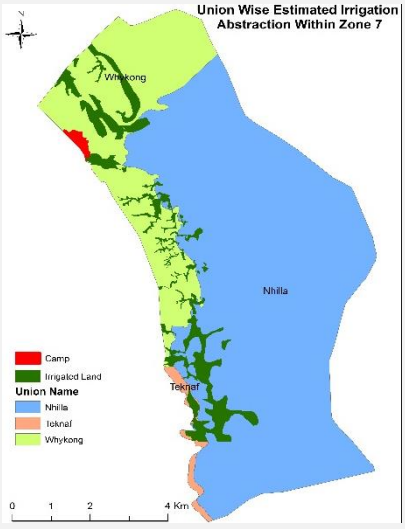
- Potential recharge in Zone 7 is **30 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August



Groundwater Abstraction

- Estimated domestic consumption is 2 Mm^3/yr considering 50 litre/person/day
- Estimated irrigation consumption 3 Mm^3/yr considering 0.75m water use per unit irrigation area per year



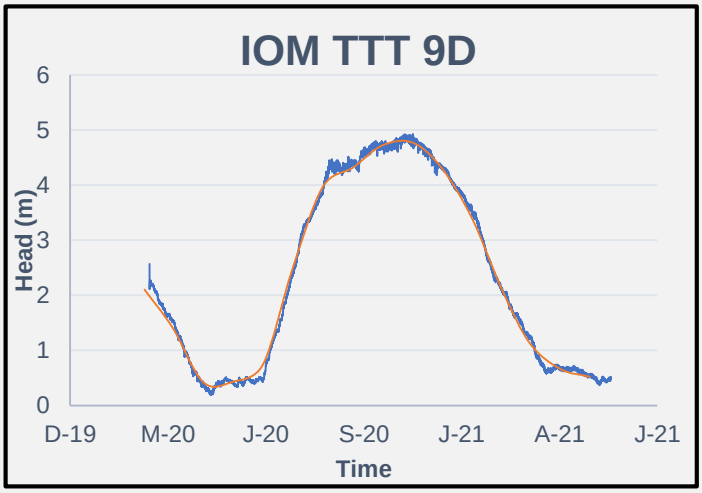


**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

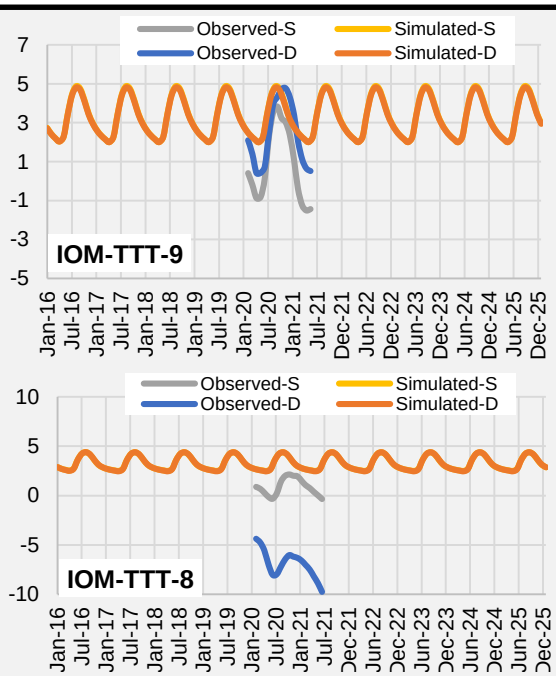
Seasonal Fluctuation

- In this zone 03 nos Monitoring well showing almost same pattern.
- Around 5m seasonal fluctuation is reported to be by automated logger data
- Water level return back to its initial stage took couple of months. Probably low permeability of the formation is the reason behind it



Groundwater Level Trend

- Auto logger data is incorporated with model projection
- which showing higher vertical fluctuation in the graph though following trend
- Highly recommended to starting effective monitoring in this zone to validate the projection

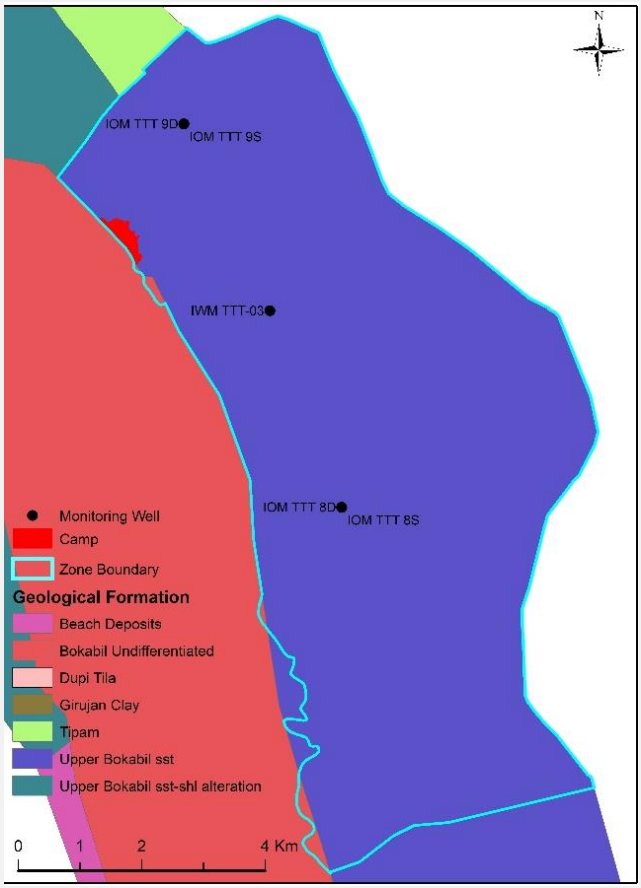


Groundwater Quality

The following water quality results are based monthly water quality analysis in one well (**IWM TTT-03)** for a period of 9 months. Reported well depth is 140 m

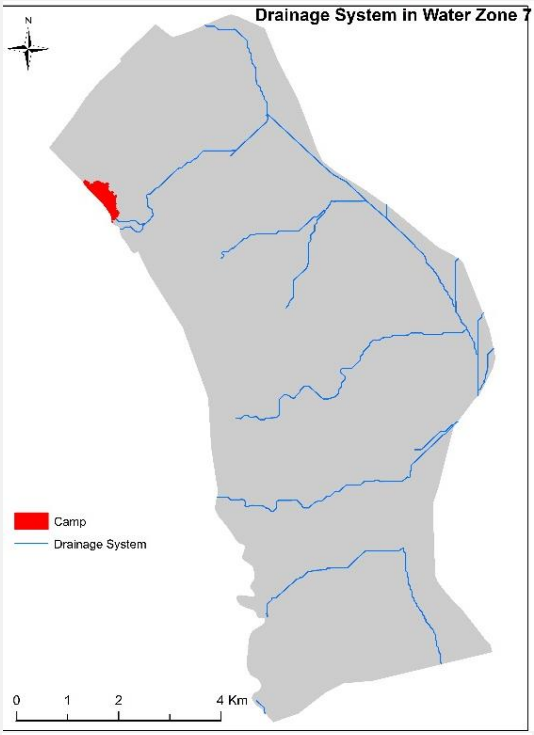
- **Salinity:** Fresh drinking water
- **Water type:** Mg-bicarbonate
- **Nitrate:** Within Bangladesh standard limit
- **Fluoride:** Within Bangladesh standard limit
- **Iron:** Within Bangladesh standard limit
- **Microbial Contamination:** There is no trace of E-coli found in the monitoring wells

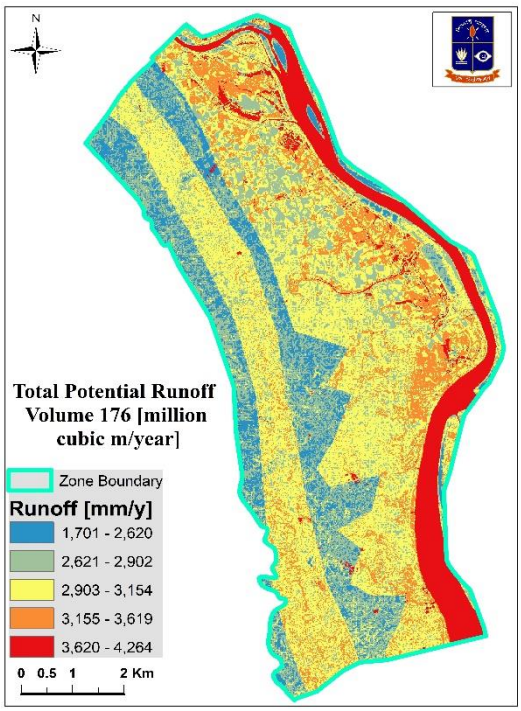
Parameter	Bangladesh Standard for Drinking Water ECR'97	No sample	Max	Min
pH	6.5-8.5	1	8.32	7.22
Temp (˚C)	20-30˚C	1	28.2	24.5
EC (uS/cm)	N/A	1	630	473
Fe mg/l	0.3-1.0mg/l	1	0.17	0.04
E-Coli	0 cfu	1	Nil	
Mn	0.1 mg/l	1	0.07	0.01
Fl-	1.0 mg/l	1	0.02	0
NO3-	10 mg/l	1	2.24	0.42



Surface Water Potentiality

- Less population and cultivation found in this zone
- Some seasonal/ intermittent local stream develops in wet season
- Annual surface runoff is 176 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage
- There are hilly terrain in the eastern boundary of the Zone, surface water reservoir may be created in that part





Summary and Recommendation

Summary

- Groundwater potentiality is good
- Surface water potentiality is low
- Estimated annual water demand is around 5 Mm^3/yr where estimated annual recharge is well higher then demand ~30 Mm^3/yr
- Despite high potential recharge groundwater level drops more than 5 m during dry period
- Sharp declination of groundwater level may be due to high irrigation pumping and low yield and transmissivity of the aquifer
- Water quality is good for drinking purpose

Overall Recommendation

- Groundwater can be used but abstraction technology must be appropriate for the high seasonal water table
- Deeper wells (>150 m) can be considered for domestic supply
- Increase irrigation water efficiency

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
- Monitoring of both groundwater level and monthly water quality for at least a year
- Feasibility for artificial recharge in wet period can be studied
- Long term monitoring of water level is essential to any future impact of camp pumping in this zone

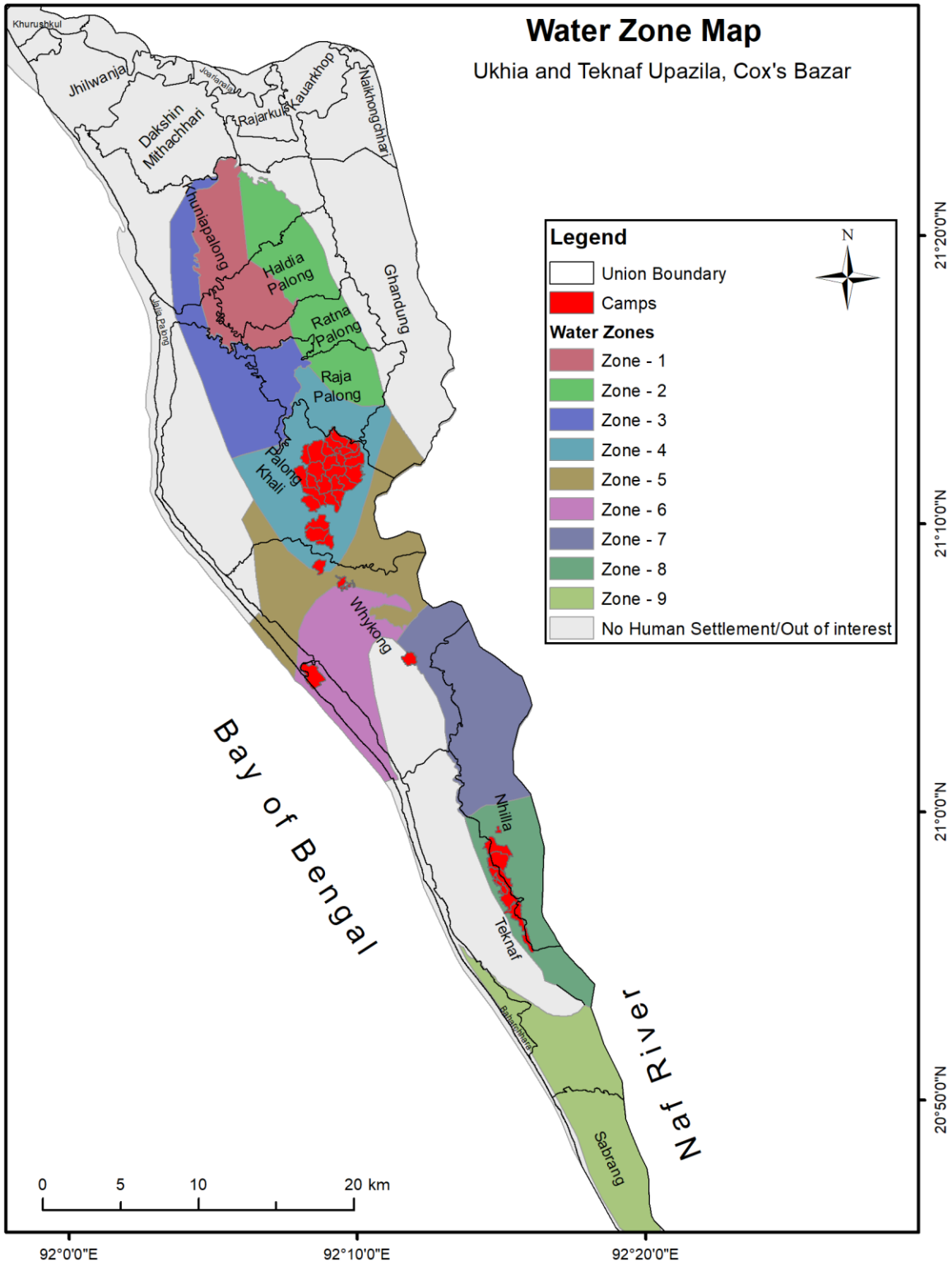
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-8

WATER ZONES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Zone - 5
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Zone - 7
Zone - 8
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No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER Zone-8

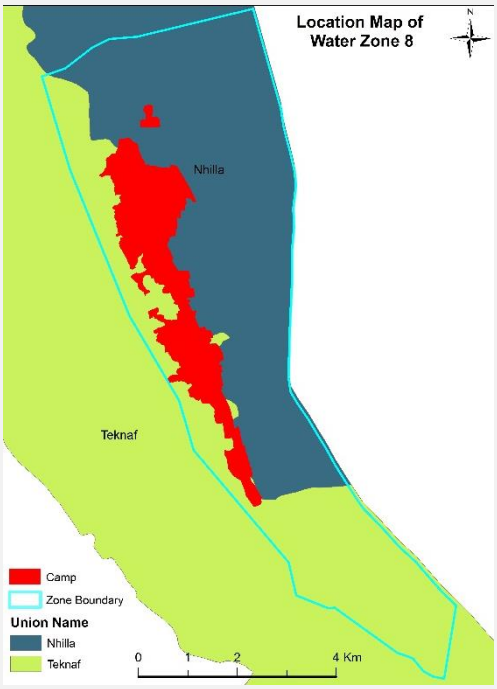
Geographic Location

Nhila Union

- Dakshin Nhila union

Teknaf Union

- Some part of teknaf union in the south



Aquifer Description

Tipam Aquifer

- **Depth**: Recent sediments to 250 m (could be even more yet to explore)
- **Type**: Confined
- **Nature**: Less heterogeneous than Dupi Tila
- **Hydraulic Properties:** Unknown; assumed to be relatively high transmissivity and storativity

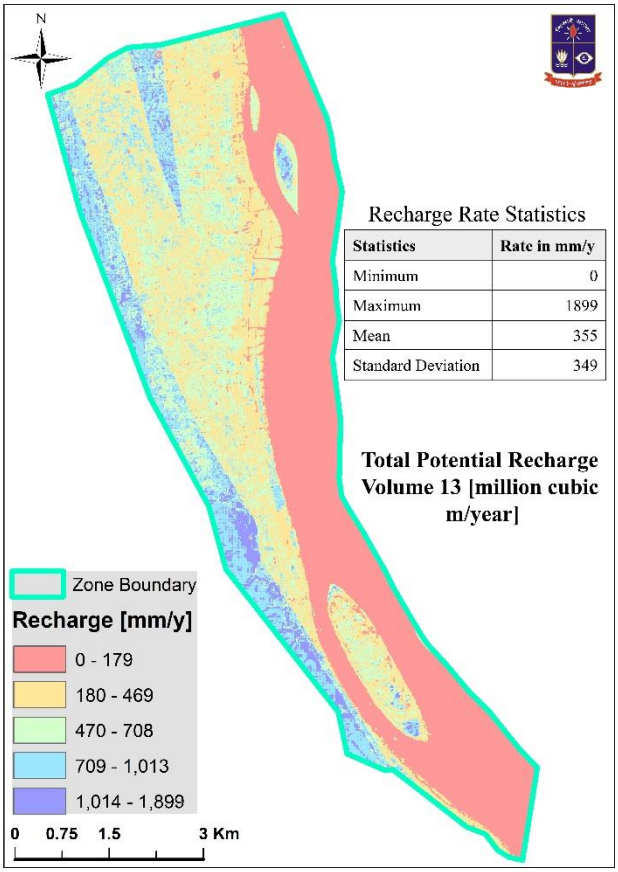
Upper Bokabil Sandstone Aquifer

- **Depth**: uncertainty lies with depth
- **Type**: Unconfined to semi-confined
- **Nature**: less heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively very low transmissivity and low storativity in this zone

Groundwater Availability and Abstraction

Groundwater Recharge Potential

- Potential recharge in Zone 8 is **13 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August



Groundwater Abstraction

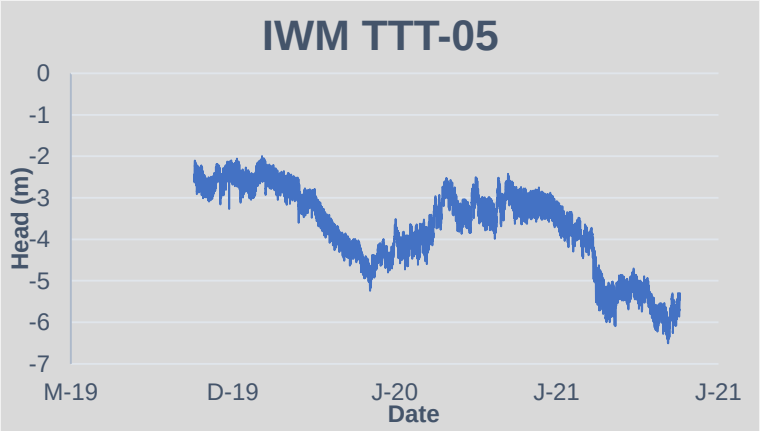
- No information

**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

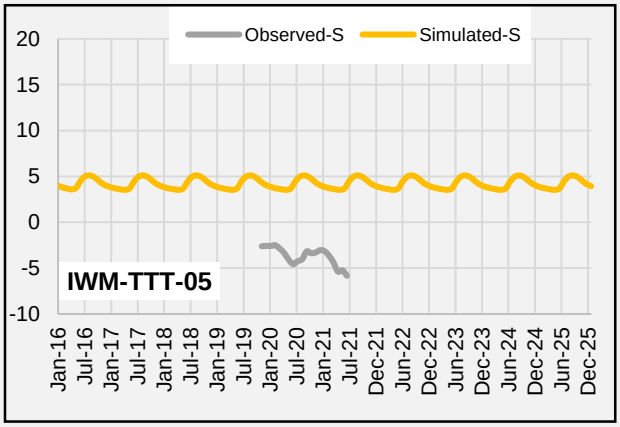
Seasonal Fluctuation

- In this zone its difficult to understand the groundwater level despite having 02 nos Monitoring wells.
- A groundwater declining trend showing in IWM TTT-05 well with 5~6 m seasonal fluctuation.
- From manual reading in IWM TTT-05 is showing a trend of declination of water level but lack of authenticate data does not allow to comment



Groundwater Level Trend

- Water level data was incorporated with model projection which showing higher vertical fluctuation in the graph.
- Highly recommended to starting effective monitoring in this zone to validate the projection

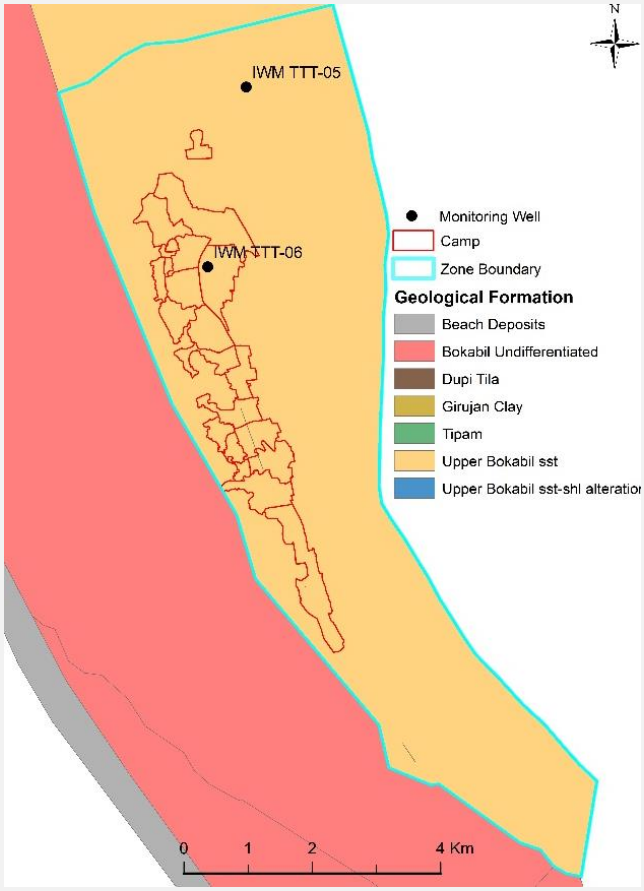


Groundwater Quality

The following water quality results are based monthly water quality analysis in two wells (**IWM TTT-05** and **IWM TTT-06)** for a period of 9 months. Reported well depths are in the range of 110 to 150 m

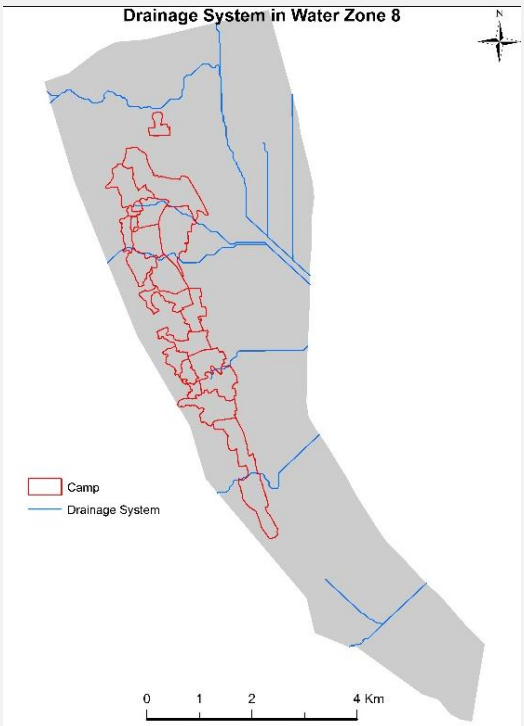
- **Salinity:** Fresh drinking water
- **Water type:** Sodium Chloride
- **Nitrate:** Higher then standard on **IWM TTT-05 about 30 mg/l in month of December'19**
- **EC: Found well above then standard in IWM TTT-05 in December'19 10930 and follow the trend upto January'20**
- **Fluoride:** Below Bangladesh standard
- **Iron:** Within Bangladesh Standard
- **Microbial Contamination:** There is no trace of E-coli found in the monitoring wells

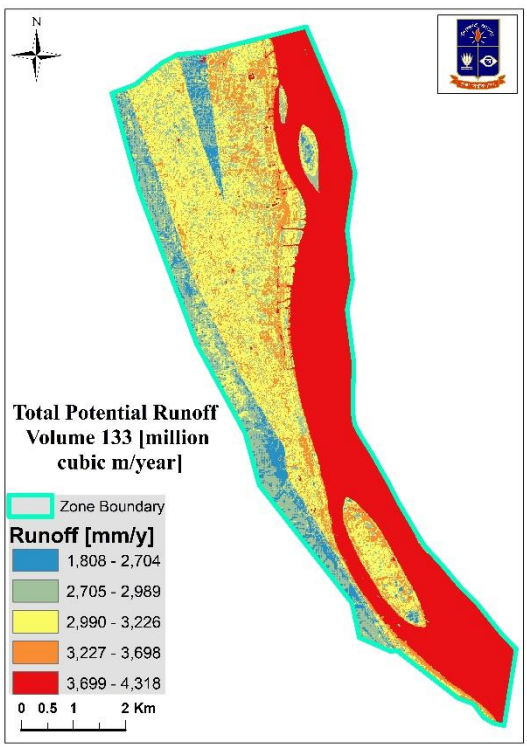
Parameter	Bangladesh Standard for Drinking Water ECR'97	No sample	Max	Min
pH	6.5-8.5	2	8.33	6.91
Temp (˚C)	20-30˚C	2	31.1	26.9
EC (uS/cm)	N/A	2	10930	831
Fe mg/l	0.3-1.0mg/l	2	2.52	0.05
E-Coli	0 cfu	2	Nil	
Mn	0.1 mg/l	1	0.58	0.09
Fl-	1.0 mg/l	2	0.27	0
NO3-	10 mg/l	2	30.0	0



Surface Water Potentiality

- Some seasonal/ intermittent local stream develops in wet season
- Annual surface runoff is 133 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage





Summary and Recommendation

Summary

- Groundwater potentiality is not good here in zone-8
- Surface water potentiality is also low
- Estimated annual water demand is around is unknown where estimated annual recharge is very low ~13Mm^3/yr
- Groundwater level drops around 5~6 m in dry period
- Sharp declination of groundwater level may be due to high irrigation pumping and low yield and transmissivity of the aquifer
- Water quality is yet to examine

Challenges and Issues

- Electrical conductivity and Nitrate found well above then standard, need to verify it to declaire safe drinking water
- There is an impression of groundwater mining from IWM TTT-05 need to verify it.

Overall Recommendation

- Groundwater can be used but abstraction technology must be appropriate for the high seasonal water table
- Deeper wells (>150 m) can be considered for domestic supply
- Irrigation pumping should be kept shallow if electrical conductivity found in standard

Summary and Recommendation

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No settlement and irrigation information
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
- Required at least two (02) more sets of multi-depth piezometer
- Monitoring of both groundwater level and monthly water quality for at least a year
- Feasibility for effective management of high surface runoff

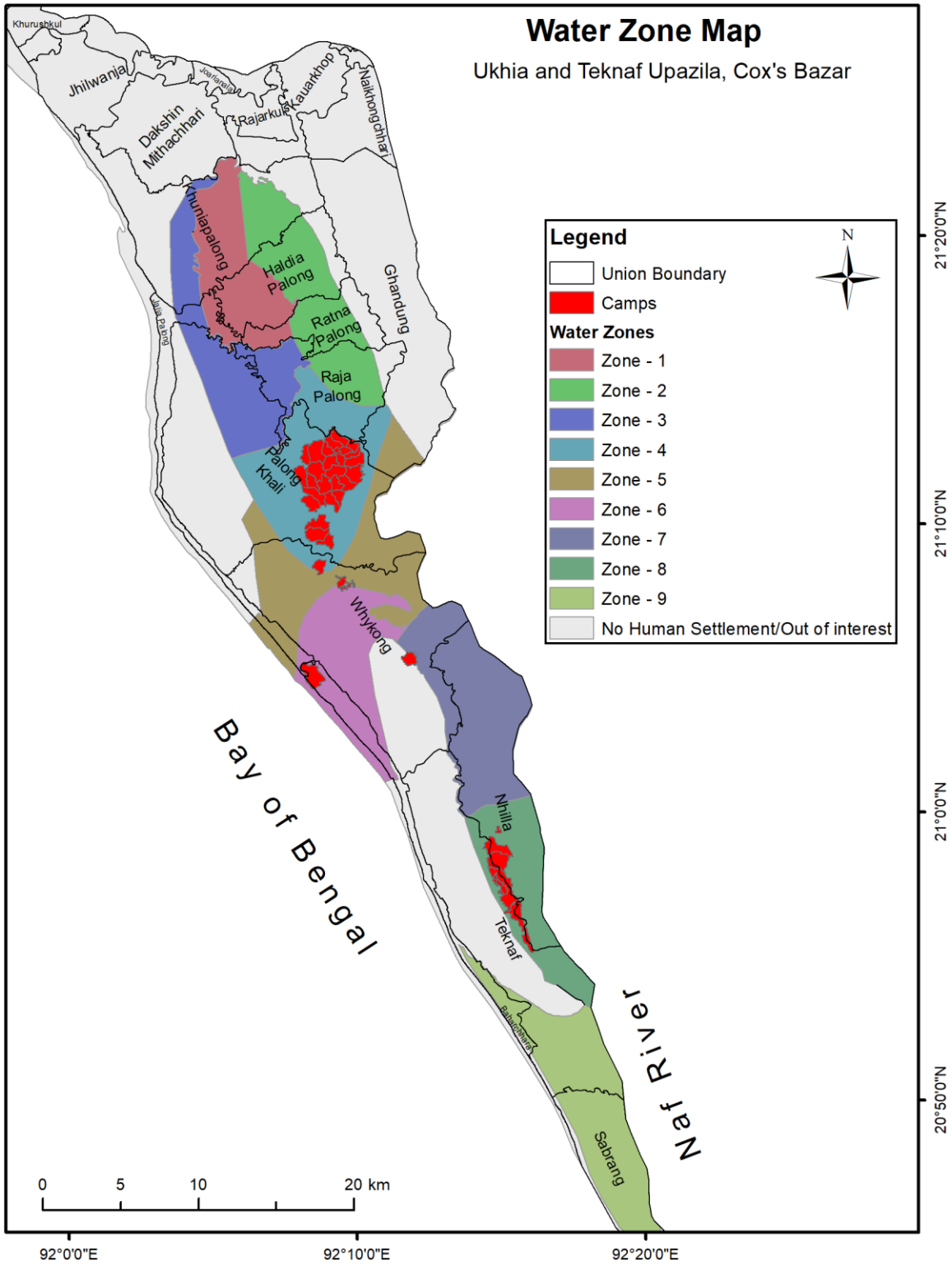
References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar

WATER ZONE MAPPING IN UKHIA-TEKNAF REGION COX'S BAZAR, BANGLADESH

Summary Report for Zone-9

WATER ZONES


Water Zone Map
Ukhia and Teknaf Upazila, Cox's Bazar
Legend
Union Boundary
Camps
Water Zones
Zone - 1
Zone - 2
Zone - 3
Zone - 4
Zone - 5
Zone - 6
Zone - 7
Zone - 8
Zone - 9
No Human Settlement/Out of interest
N
Khurushkul
Jhilwanja
Dakshin Mithachhari
Rajarkul
Kauarkhop
Nakhongchhari
Khuniapalong
Haldia Palong
Ratna Palong
Raja Palong
Palong Khali
Ghandung
Whykong
Nhilla
Teknaf
Sabrang
Bay of Bengal
Naf River
0
5
10
20 km
92°0'0"E
92°10'0"E
92°20'0"E
21°20'0"N
21°10'0"N
21°0'0"N
20°50'0"N

WATER Zone-9

Geographic Location

Baharchara Union

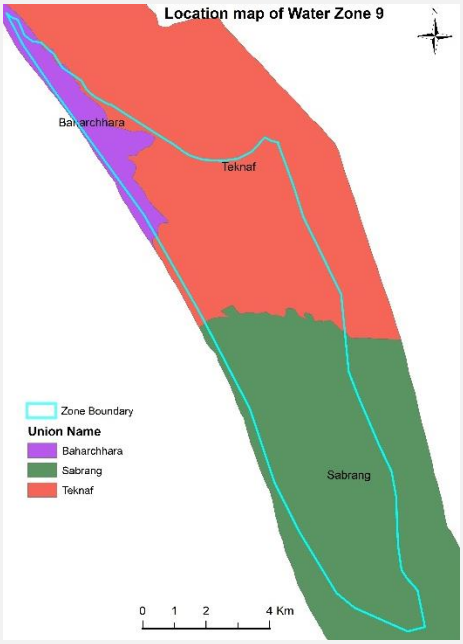
- Baharchara in the north

Teknaf Union

- Teknaf mouza in central part

Sabrang Union

- Sabrang in the southern part of the zone
- Shah porir dwip Mouza



Aquifer Description

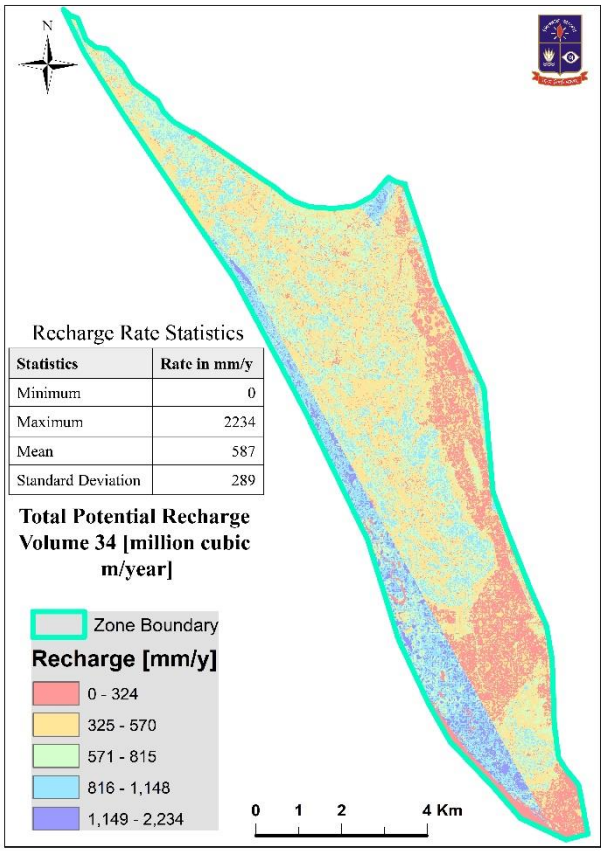
Upper Bokabil Sandstone Aquifer

- **Depth**: uncertainty lies with depth
- **Type**: Unconfined to semi-confined
- **Nature**: less heterogeneous with numerous interbedded clay layers of variable thickness and extent at different depths
- **Hydraulic Properties:** Unknown; assumed to be of relatively very low transmissivity and low storativity in this zone

Groundwater Availability and Abstraction

Groundwater Recharge Potential

- Potential recharge in Zone 9 is **34 [Mm^3/y]***
- Recharge time May to September
- Highest in June to August



Groundwater Abstraction

- No info

**Groundwater recharge rate is estimated based on a physically based model [Saedek, 2019]. The spatial variability is due to a number of factors including topography, landuse, soil type, groundwater level and climate. Average Rate of potential recharge in zone-1 is 920 mm/y with a standard deviation of 350 mm/y. The volumetric recharge estimated here is the potential recharge and should considered as the upper bound. The actual value of recharge should be less than this estimate and will vary depending on groundwater abstraction and local hydrogeological variability in the scale less than what is considered in the recharge model.*

Groundwater Level

Seasonal Fluctuation

- No water level data in this zone

Groundwater Level Trend

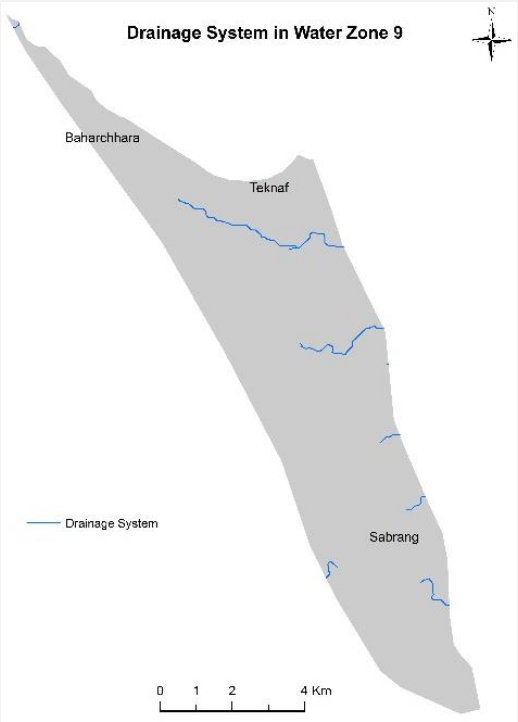
- No groundwater level trend in zone-9

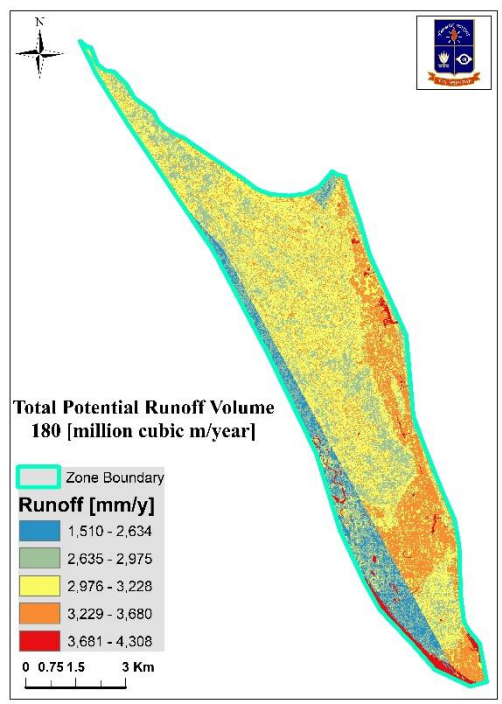
Groundwater Quality

No info of water quality in this zone-9

Surface Water Potentiality

- Some seasonal/ intermittent local stream develops in wet season
- Annual surface runoff is 180 Mm^3
- Although runoff is high, utilization potential of surface water is low because of absence of well defined drainage





Summary and Recommendation

Summary

- Groundwater potentiality is very low
- Surface water potentiality is low
- Estimated annual water demand is unknown where estimated annual recharge is ~34Mm^3/yr
- Very limited information in this zone need to enhance it.
- Difficult to recommend anything without adequate data

Uncertainties and Further Activities

- There are a number of uncertainties in this Zone
    - No primary data on aquifer parameters
    - No multi depth groundwater level and quality monitoring
    - No data on exact depth of domestic and irrigation pumping
    - No data on irrigation water use efficiency
- Required at least three (03) more sets of multi-depth piezometer
- Monitoring of both groundwater level and monthly water quality for at least a year
- Couple of capacity building program on proper groundwater management with stakeholders for sustainable water supply
- Feasibility for artificial recharge in wet period can be studied
- Long term monitoring of water level is essential to any future impact of camp pumping in this zone

References

1. Saedek, S., (2019) Estimation of Potential Recharge to the Dupi Tila Aquifer in Ukhia, Cox's Bazar Using GIS Based Water Balance Method. MS Thesis, Department of Geology, University of Dhaka
2. IOM (2020) Conceptual Understanding of the Principal Aquifer Systems in the Cox's Bazar District, International Organization for Migration, Cox's Bazar