YANGON TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING

ASSESSMENT OF AYEYARWADDY RIVER WATER QUALITY

Dr. Cho Cho Thin Kyi
Associate Professor,YTU
Cho Cho Htun

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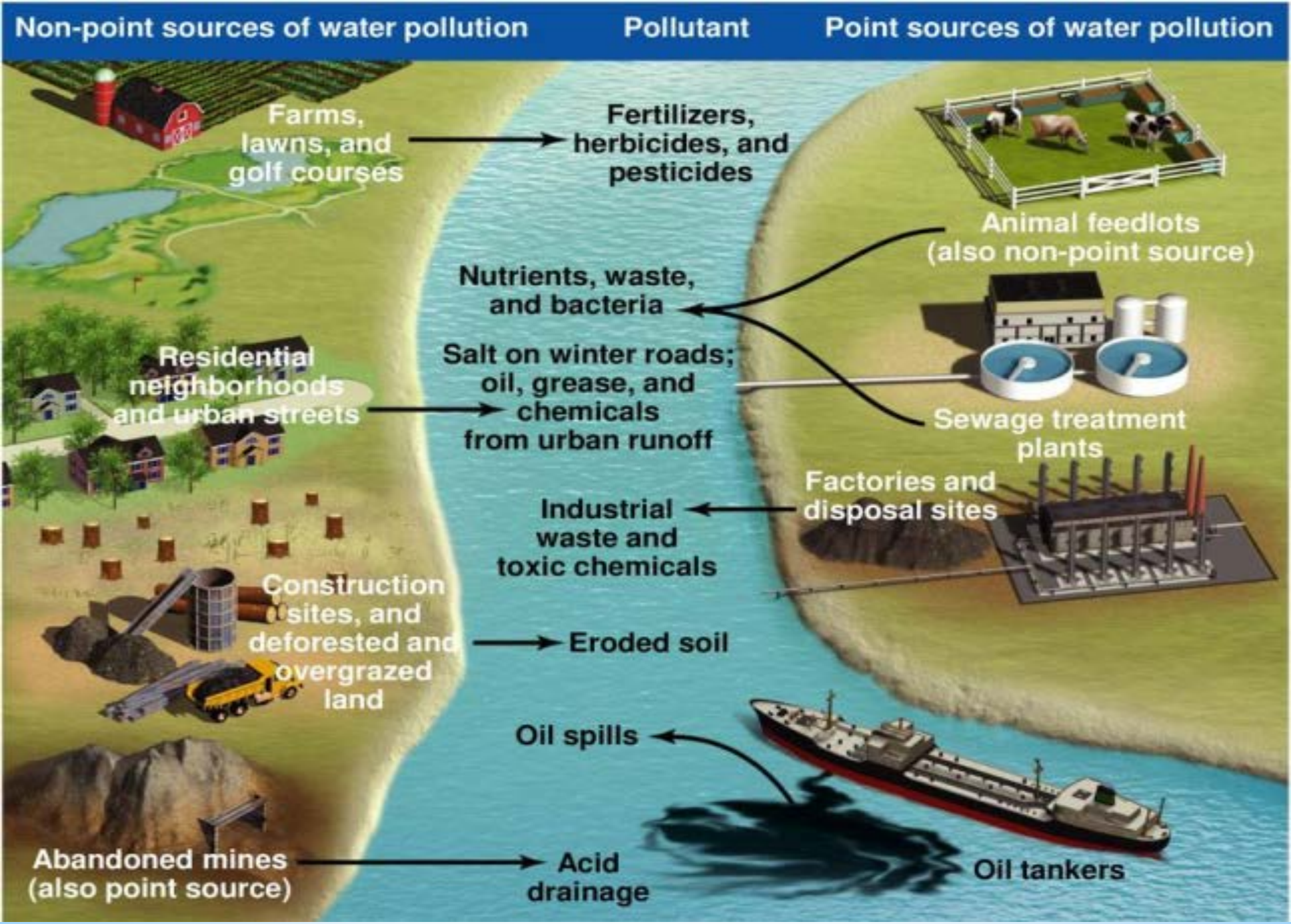
Outlines

1. Introduction
2. Ayeyarwaddy River
3. Standard Compared
4. Water Quality measurements and WQI
5. Test Results and Discussion
6. Conclusions
7. Recommendation

Introduction

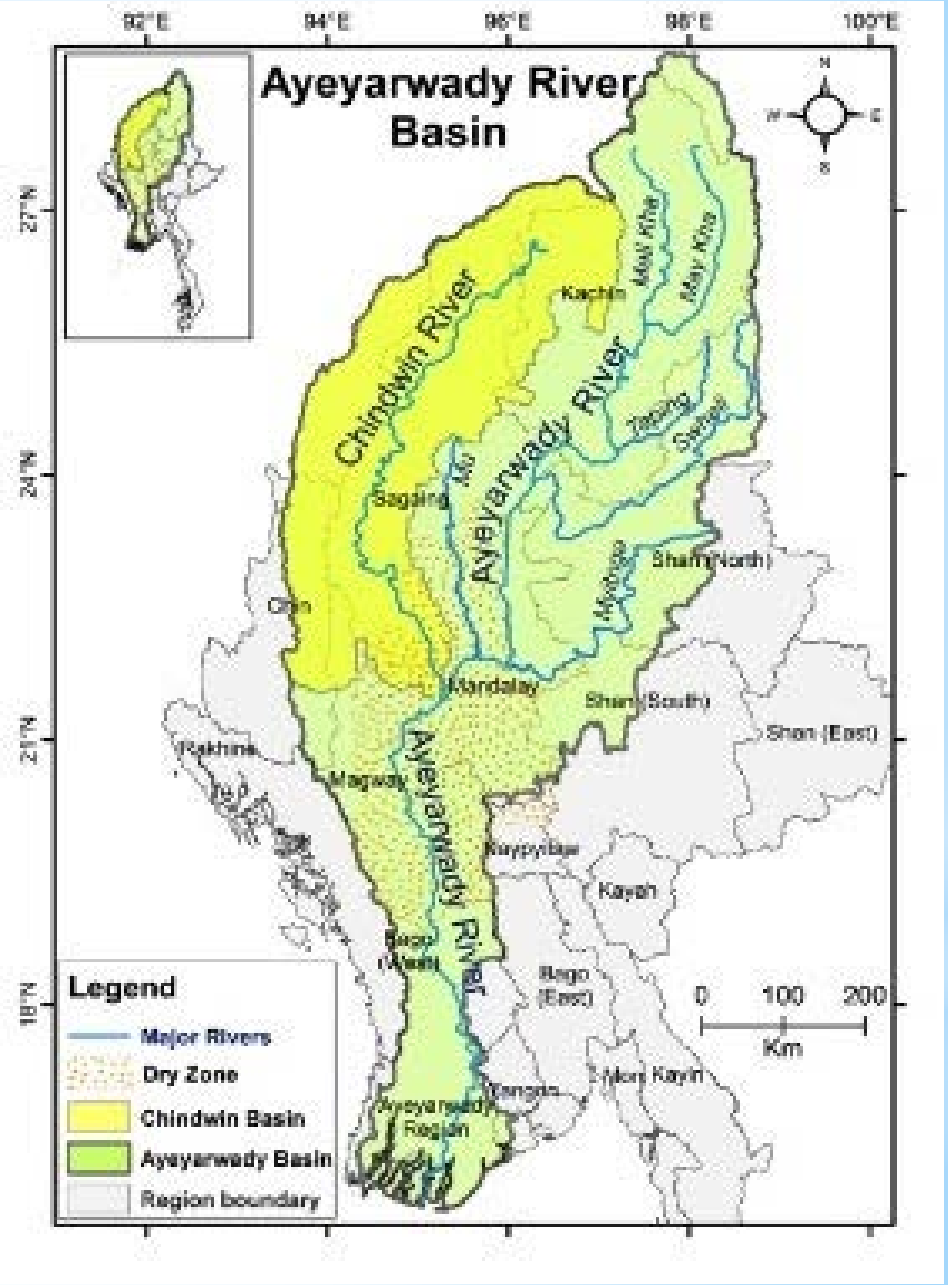
- Water quality is defined as the **physical, chemical and biological characteristics** of a water body
- it can be determined by analyzing various **physico-chemical parameters and biological parameters** in order to check the quality status of water, whether it is **suitable for drinking, irrigation or fishing** practices.
- **Rivers and lakes** are the most important **freshwater resources** for human , ecosystem and environment.
- Unfortunately, river water are being polluted by indiscriminate **disposal of sewerage, industrial waste and excess of human activities**, which affects their **physico-chemical characteristics and microbiological quality.**
- Therefore, **monitoring of River water quality** is necessary on downstream of the confluence of the wastewater into river.



Source ; Pearson Benjamin Cummings

Ayeyarwaddy

- Length – 2,170 km
- drainage basin area -412,650 km2
- Annual average discharge - 410 km3/year
- Navigable length – 1,534 km




Agricultural


Industrial


Bathing


Domestic


Fishing

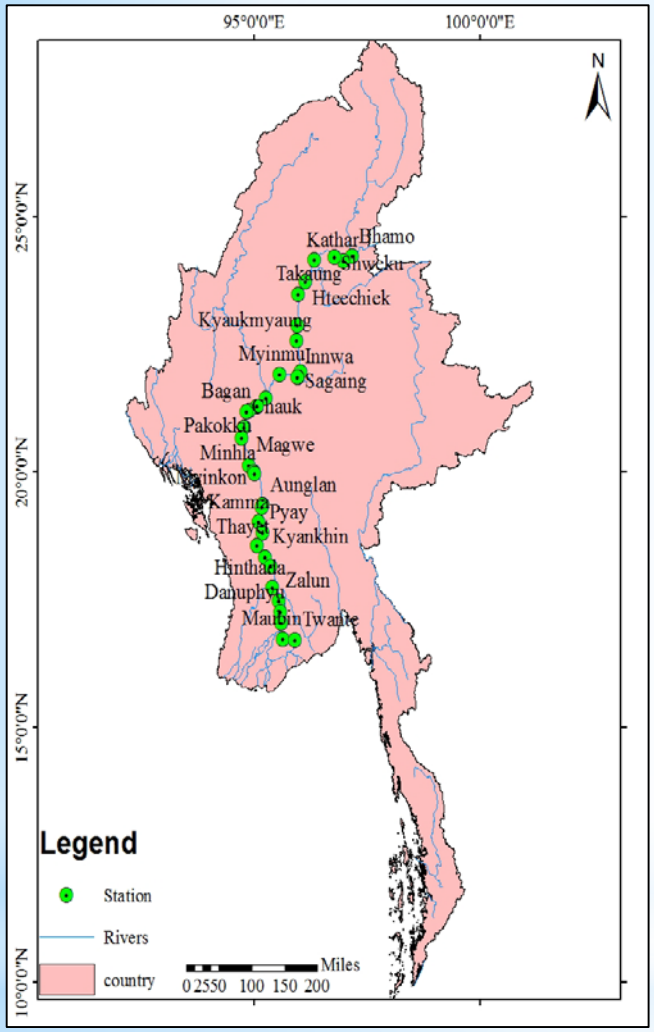

Transportation

Parameters and Frequency

Physicochemical Parameters	Frequency
1. pH 2. Temperature, 3. Turbidity 4. Total Hardness (TH) 5. Total Alkalinity (TA) 6. Dissolved Oxygen (DO) 7. Chloride (Cl) 8. Iron (Fe) 9. Ammonia (NH3) 10. Nitrite (NO2-) 11. Fluoride (F-)	1st time in January, 2012 2nd time in February, 2013 3rd time in February, 2015

- The water samples were collected and tested during the low flow period of the year by Directorate of Water Resources and Improvement of River Systems (DWIR)

Sampling Locations



Stations	Description
Bhamo,Sinkham,Shweku,Katha,Htichaight, Takaung,Thabeikkyin, Kyaukmyaung,Mandalay,Sagaing,Innwa,Myinmu (11)	Middle Ayeyarwaddy River Basin (north to the confluence with the Chindwin)
Myingyan, Pakokku, Naungoo, Bagan, Chauk, Sinphyukyoon, Magway, Myinkon, Minhla, Aunglan, Thayet, Kamma, Pyay, Seikathar, Kyankhin (15)	Lower Ayeyarwaddy River Basin
Myaungaung, Hinthada, Zalun, Dhanuphyu, Naungdone, Maubin, Twante(7)	Ayeyarwaddy Delta

- The water sample stations also were chosen in the urban area, agricultural area and delta area along the Ayeyarwaddy River by DWIR.

Standard Compared

Surface Water Quality Standard of Malaysia	
CLASS	**USES**
Class I	**Conservation of natural environment.** **Water Supply I – Practically no treatment necessary.** **Fishery I – Very sensitive aquatic species**
Class IIA	**Water Supply II – Conventional treatment required.**
	Fishery II – Sensitive aquatic species.
Class IIB	**Recreational use with body contact.**
Class III	**Water Supply III - Extensive treatment required.**
	Fishery III - Common, of economic value and tolerant species; livestock drinking.
Class IV	**Irrigation**
Class V	**None of the above.**

Standards Recommending

Parameters	Standard
Chloride (mg/l)	200
Iron (mg/l)	1
Ammonia (mg/l)	0.3
Hardness (mg/l)	250
Nitrite (mg/l)	0.4
Alkalinity (mg/l)	-
Fluoride (mg/l)	1.5
pH	6-9
DO (mg/l)	5-7
Turbidity (NTU)	50

Water Quality Index(WQI)

Weighted Arithmetic Mean Method

$$WQI = \frac{\sum q_n W_n}{\sum W_n}$$

Where, q_n = Quality rating of n th water quality parameter.

W_n= Unit weight of n th water quality parameter.

The quality rating (q_n), → $q_n = \frac{V_n - V_{id}}{S_n - V_{id}} \times 100$

Where,

V_n = Observed value of nth water quality parameter

V_{id} = Ideal value for nt^{h} parameter in pure water. (except pH = 7 and DO = 14.6 mg/l and 0 for all other parameters)

S_n = Standard permissible value of nth water quality parameter.

Water Quality Index(WQI),. Contd

Unit Weight (W_n) → $W_n = \frac{K}{S_n}$

k = Constant of proportionality → $k = \frac{1}{\sum \frac{1}{S_{n=1,2,\ldots,n}}}$

WQI and Corresponding Water Quality Status

Sr.No	WQI	Status	Possible usages
1	0 – 25	Excellent	Drinking, Irrigation and Industrial
2	26 – 50	Good	Domestic, Irrigation and Industrial
3	51 -75	Fair	Irrigation and Industrial
4	76 – 100	Poor	Irrigation
5	101 -150	Very Poor	Restricted use for Irrigation
6	Above 150	Unfit for Drinking	Proper treatment required before use.

Source:Horton,R.K.,1965

Results and Discussion

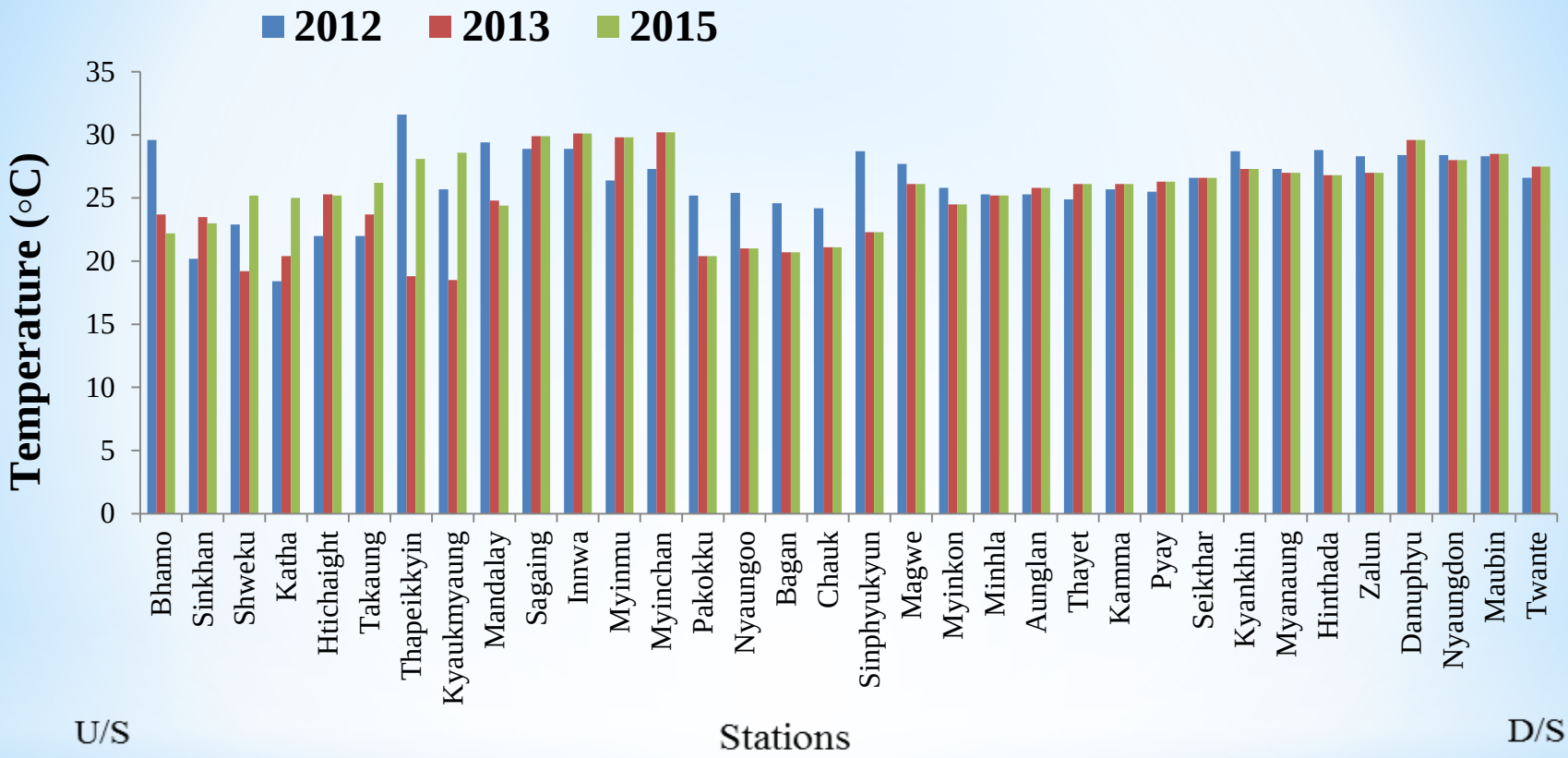


Fig.1 Temperature Variations of Sample Stations

- No set guidelines NWQS and ranged 18.4°C – 31.6 °C
- The water temperature changes as a river flows though different climatic regions with variation in atmospheric temperature.

Results and Discussion

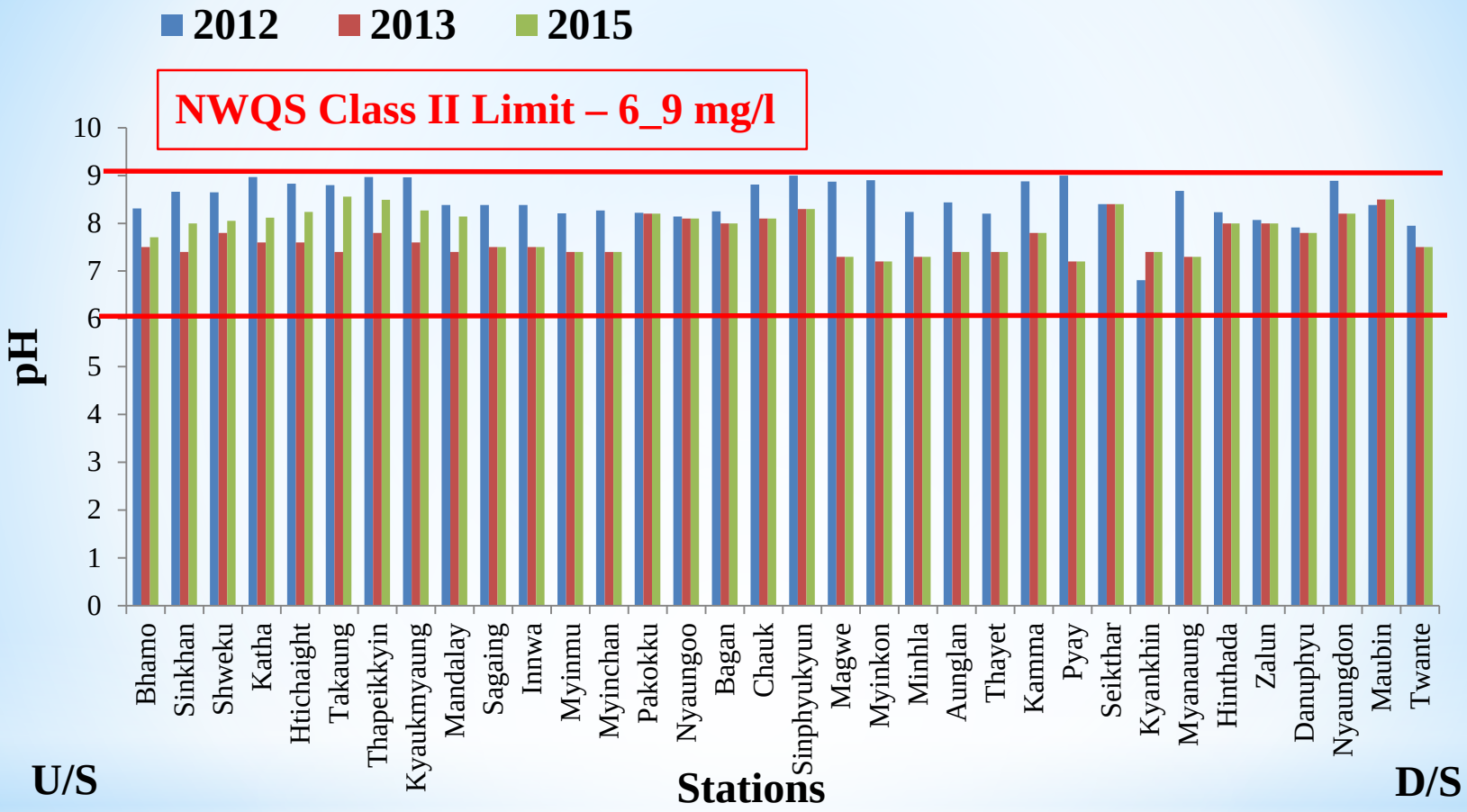


Fig.2 pH Comparison of Sample Stations with NWQS

- pH value between the standards and so aquatic life cannot be effected.
- There is no acidity condition according to the three times results.
- The increase of pH values indicated that the water is slightly neutral toward alkalinity.

Results and Discussion

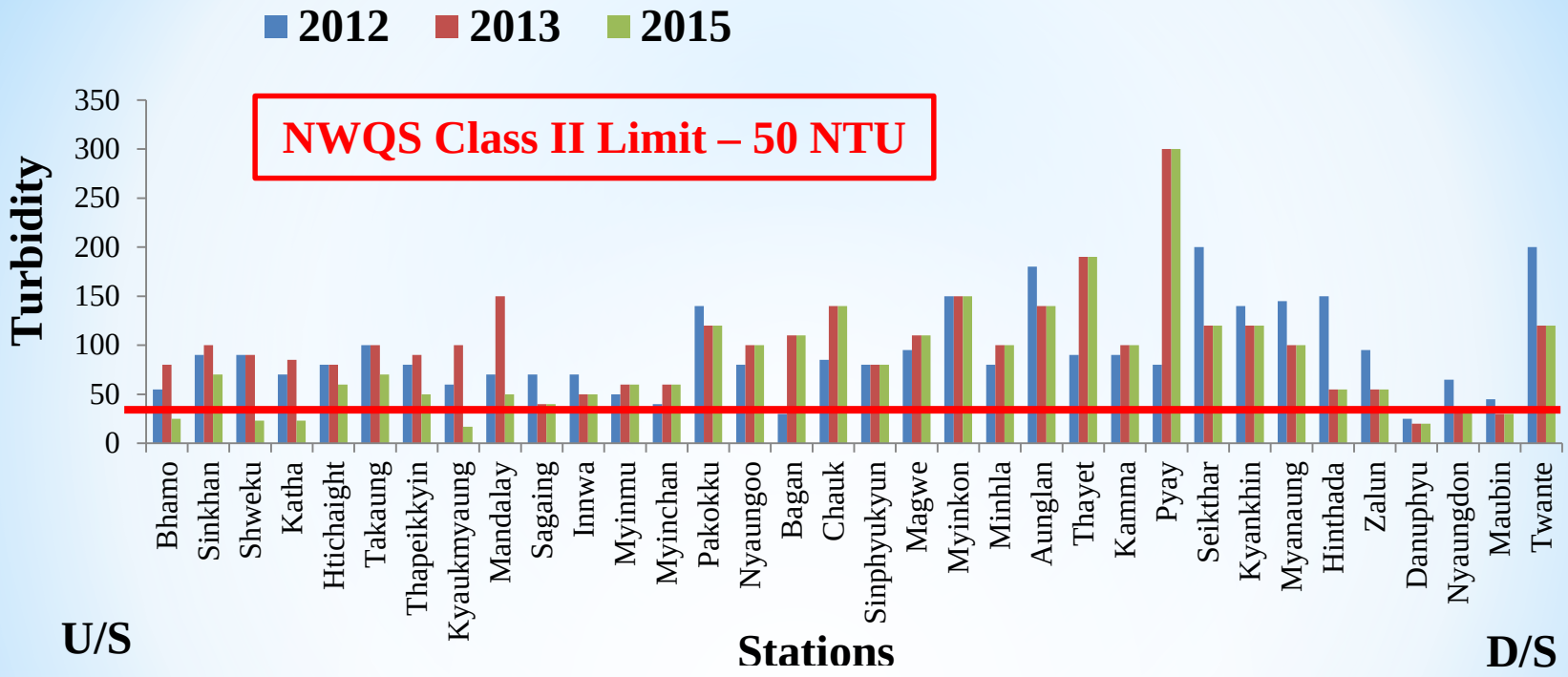


Fig.3 Turbidity Comparison of Sample Stations with NWQS

- Range between 17 NTU to 300 NTU.
- The highest value of turbidity recorded at Pyay station in 2013 and 2015.
- High turbidity increases the water temperatures and which bacteria can grow.
- High turbidity is found in agriculture area due to runoff from agricultural practices, soil particles and discharges.

Results and Discussion

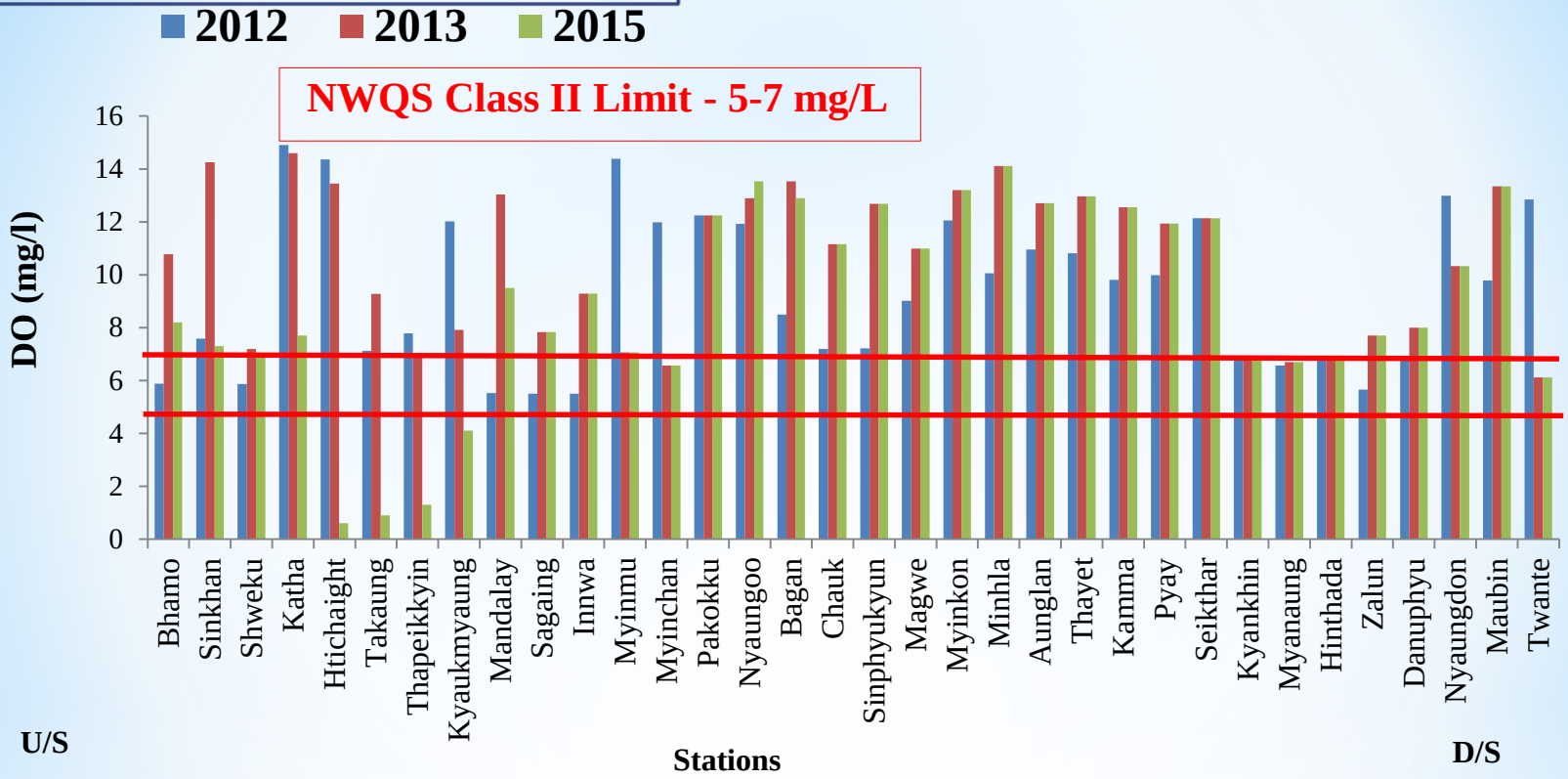


Fig.4 DO Comparison of Sample Stations with NWQS

- ranged from 0.6 to14.9 mg/l. Most of the results are higher than standard.
- The DO values are very low at the four stations (Htichaight, Takaung, Thapeikkyin and Kyaukmyaung) in 2015 due to the dumping organic wastes into the river and it is harmful the aquatic life. Low DO causes to an unbalanced ecosystem.
- The DO values show random variation from the headwaters to downstream.

Results and Discussion

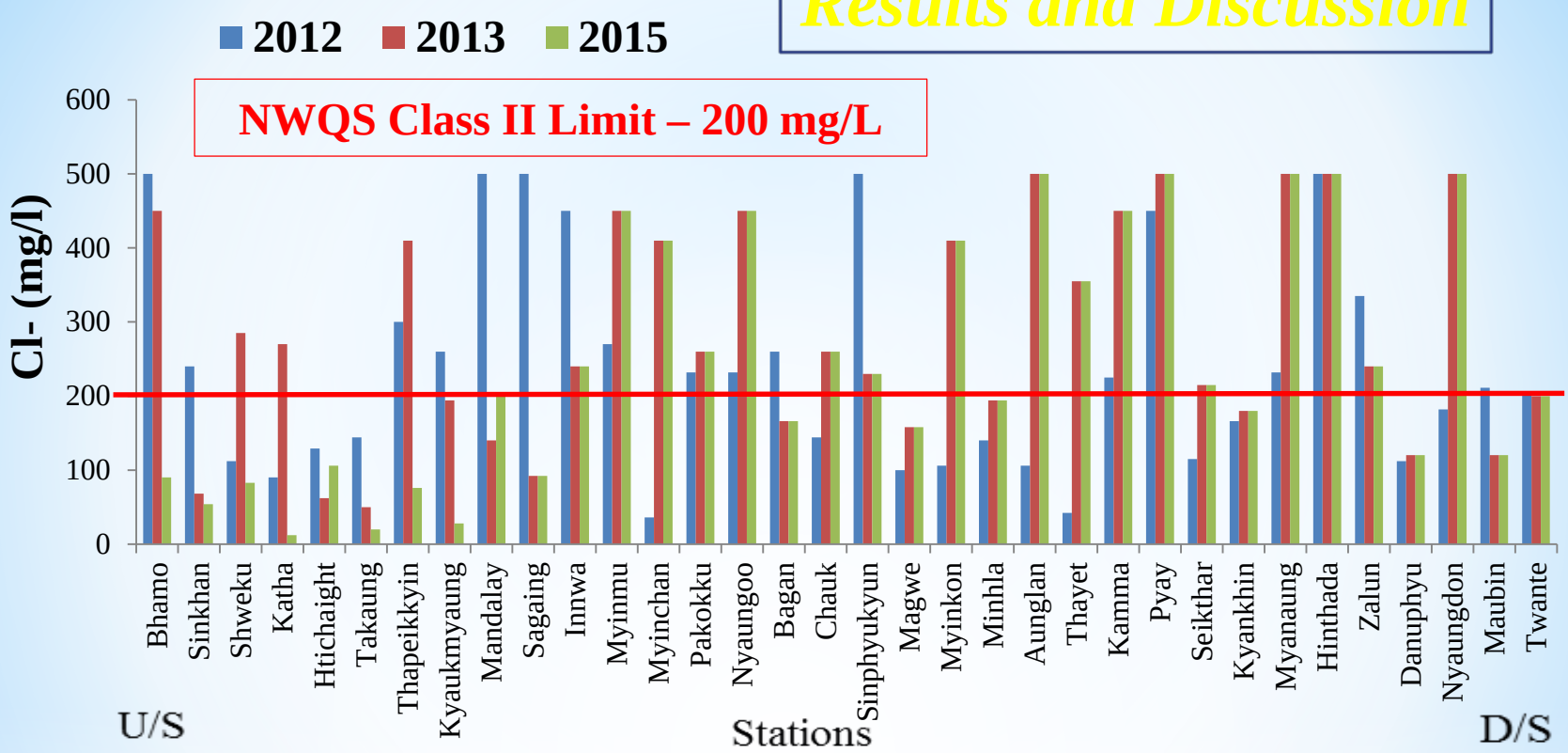


Fig.5 Chloride Comparison of Sample Stations with NWQS

- ranged from 12 mg/l – 500 mg/l.
- Only Bhamo, shweku, Mandalay, Sagaing, Innwa, Shinphyukyun and Zalun in descending order.
- High concentration link to washing clothes, discharge of domestic, industrial wastewater and surface runoffs.
- The concentration of chloride is low in the upstream during the sample time in 2015.

Results and Discussion

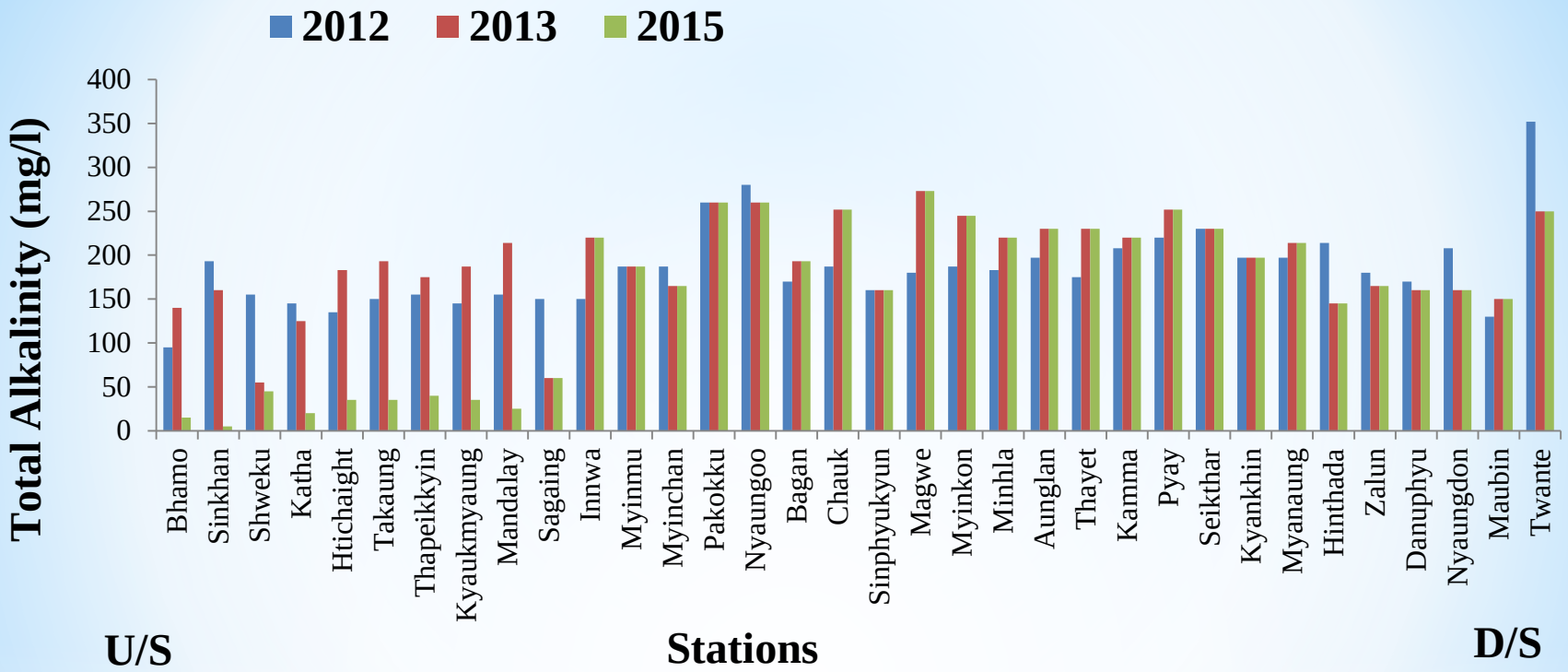


Fig.6 Total Alkalinity Comparison of Sample Stations

- the total alkalinity is ranged from 5 to 352 mg/l.
- no limitation NWQS and WHO drinking standard for TA is 600 mg/l .
- Even if, TA values compared with WHO, there is no station exceeding limits.
- In spite of lacking the TA for surface water standard, the variation of total alkalinity is reasonable and pH values are within the standard.

Results and Discussion

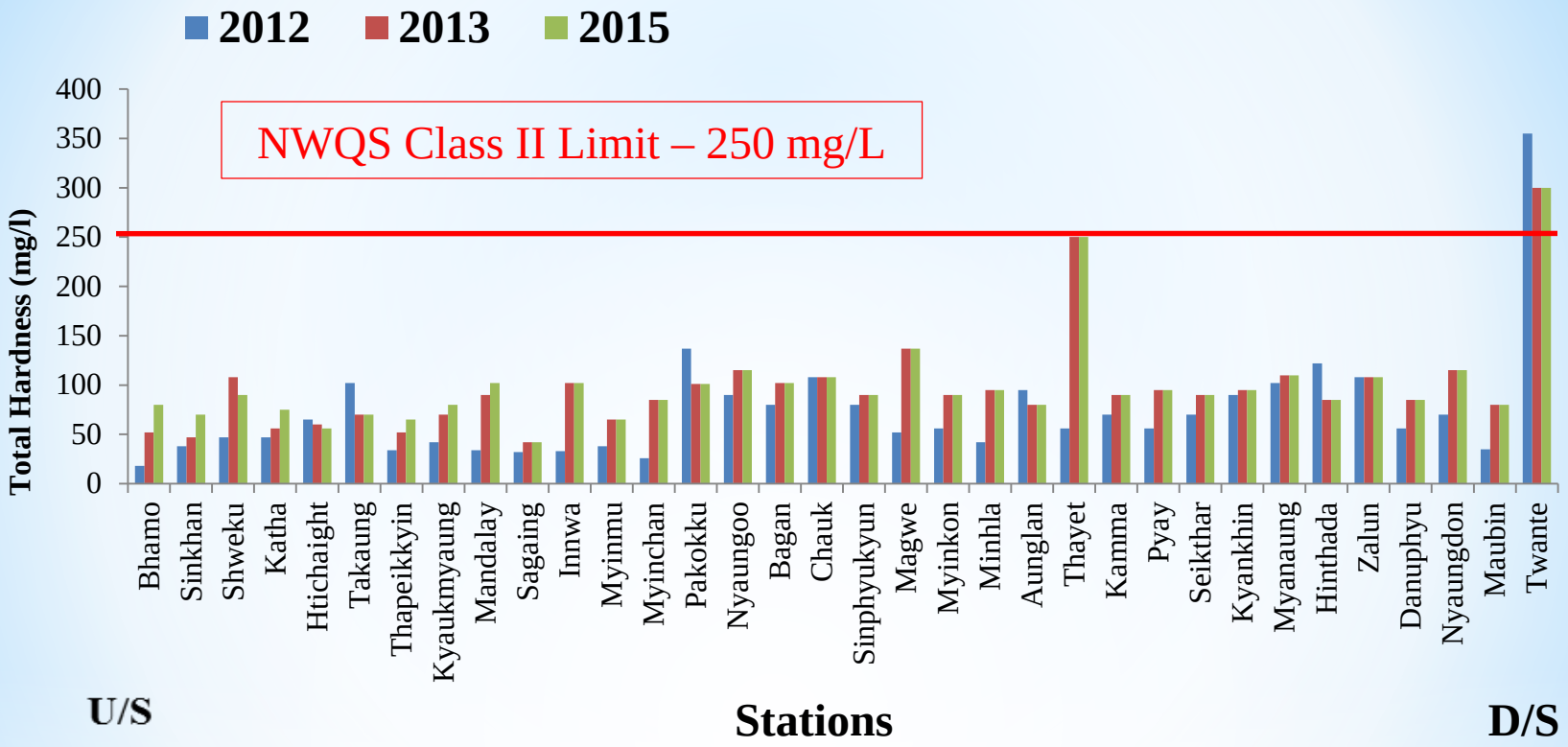


Fig.7 Total Hardness Comparison of Sample Stations with NWQS

- TH values- ranged from 18 mg/l to 355 mg/l.
- It is said that Ayeyarwaddy River water is soft water.
- The water is hard only in Twante station due to receiving the domestic sewage and industrial waste of Yangon city and intrusion of tidal water.
- The hardness and iron concentrations are lower than the standard except Twante and Pyay.

Results and Discussion

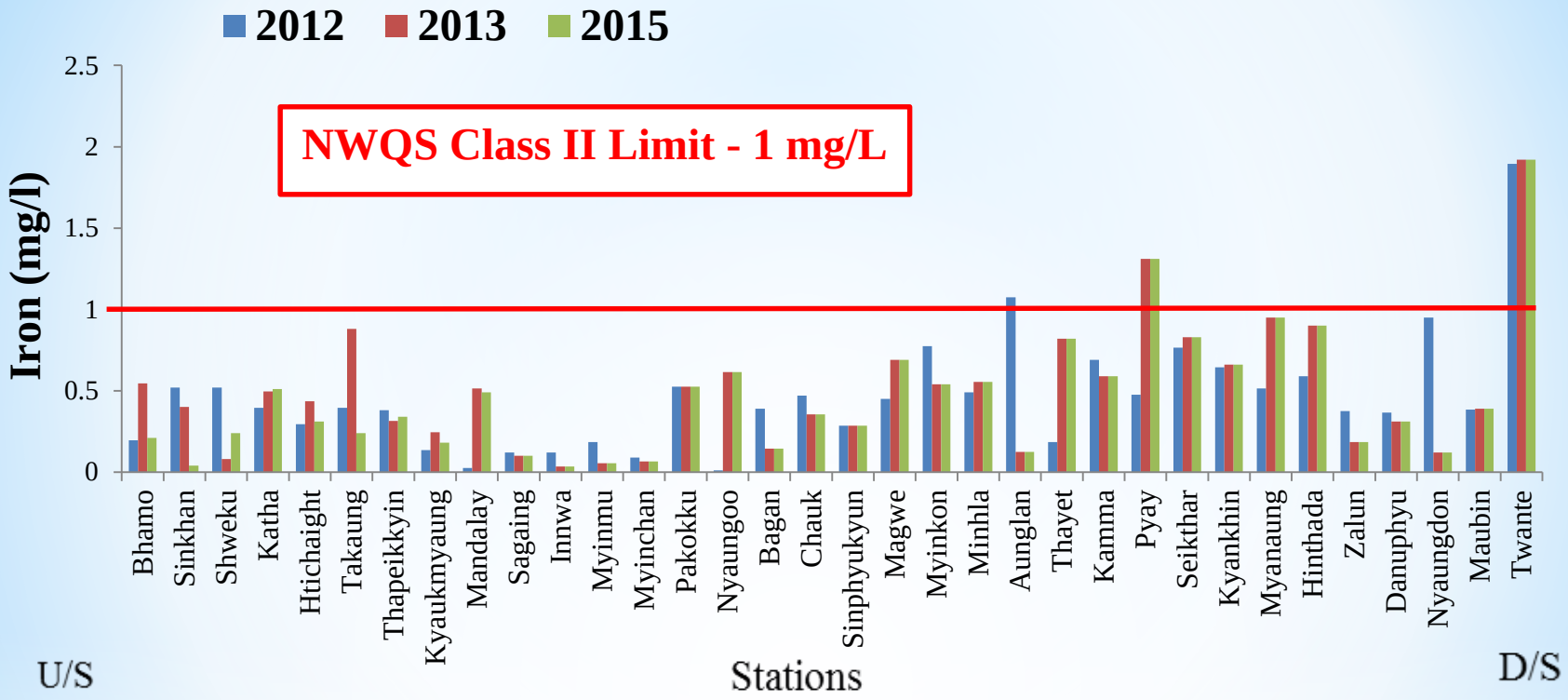


Fig.8 Iron Comparison of Sample Stations with NWQS

- ranged from 0.01 mg/l to 1.92 mg/l
- Aunglan and Twante stations in 2012 and Pyay and Twante station in 2013 and 2015 exceeding guideline value.
- High value of iron in Twante station is intrusion of tidal water and the impact of the Yangon River.

Results and Discussion

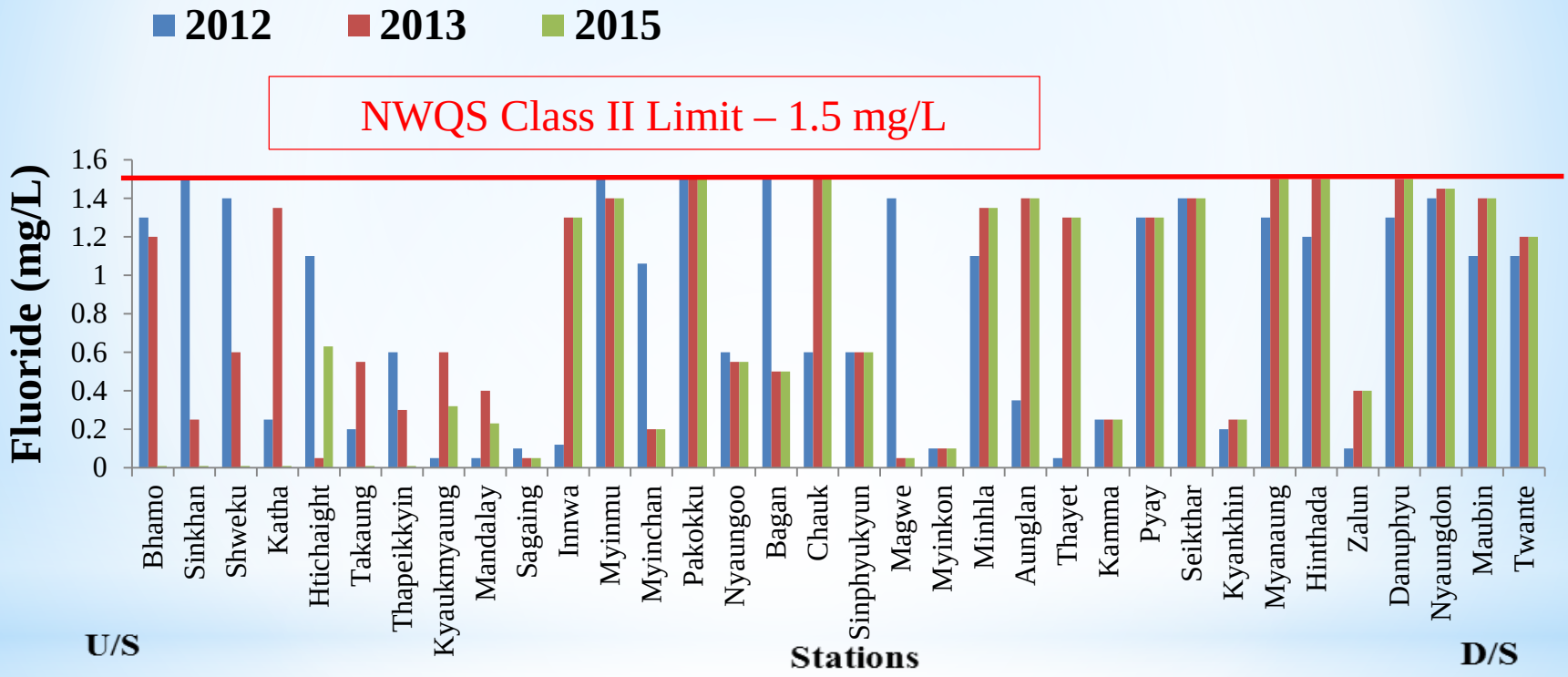


Fig.9 Fluoride Comparison of Sample Stations with NWQS

- ranged from 0.1mg/l to 1.5 mg/l
- the values of fluoride do not exceed the NWQS values (1.5 mg/l).

Results and Discussion

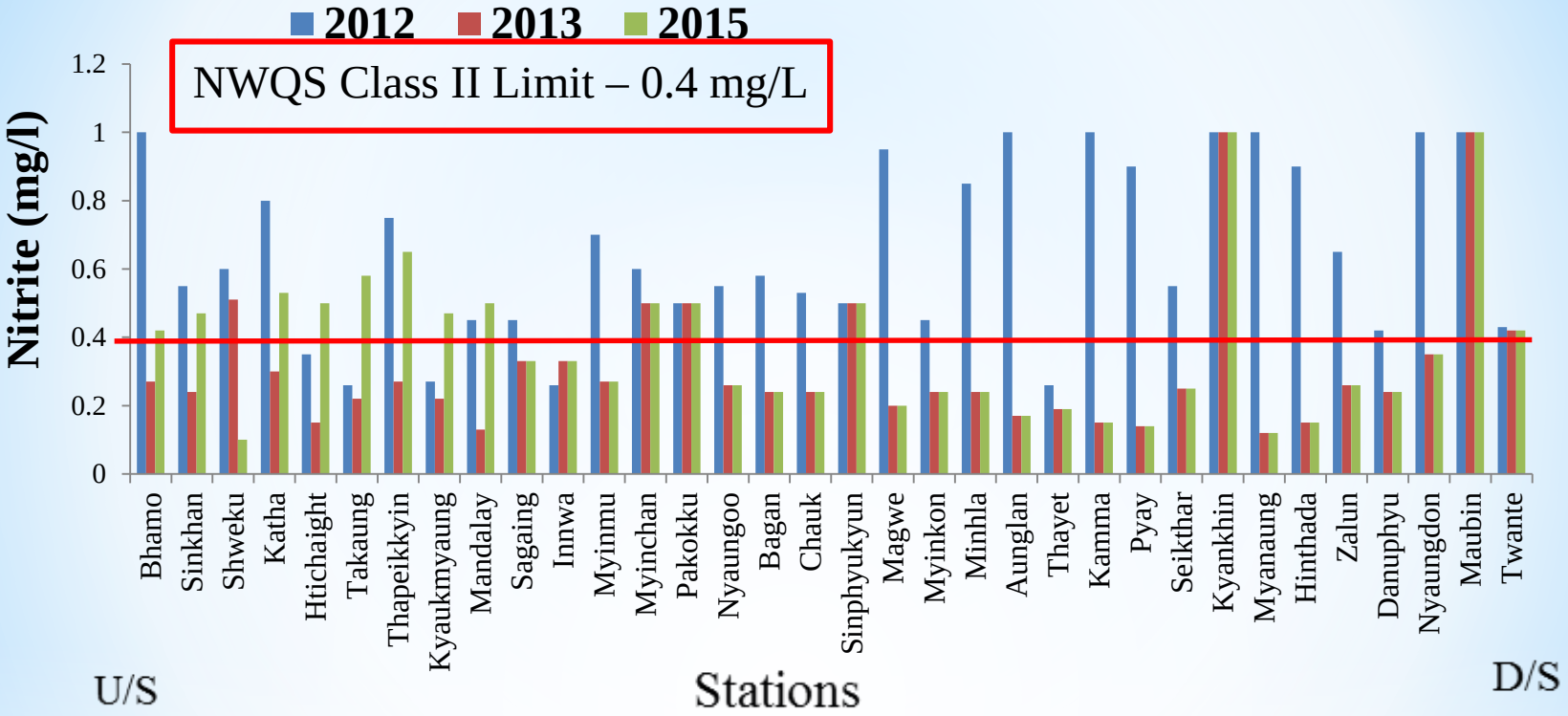


Fig.10 Nitrite Comparison of Sample Stations with NWQS

- ranged from 0.1 mg/l to 1 mg/l and most stations are higher than the standard in 2012 along the river.
- Myinchan, Pakokku, Sinphyukyun, Kyankhin, Maubin and Twante stations exceed the standard limit in Lower ARB and delta in 2013 and 2015.
- Many effluents lead to increased nitrite concentrations in river waters. Therefore, high levels of nitrite in river waters indicate pollution.

Results and Discussion

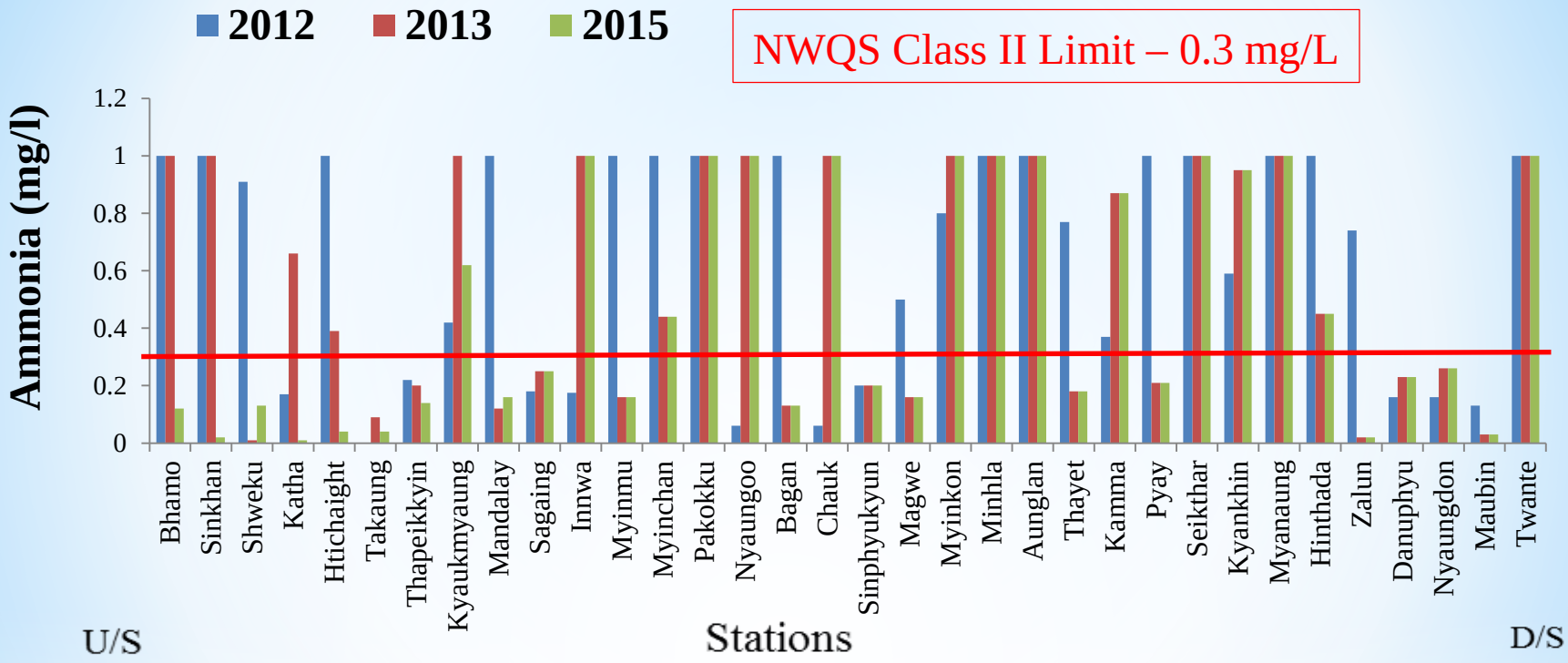


Fig.11 Ammonia Comparison of Sample Stations with NWQS

- ranged from 0.01 mg/l to 1 mg/l
- Most of the stations along the Ayeyarwaddy River are above the standard limit (0.3 mg/l). It is discharged in large quantities in industrial, municipal and agricultural waste waters.
- Ammonia in higher concentration is harmful to not only fish and other biota but also human at higher concentration.

Results and Discussion

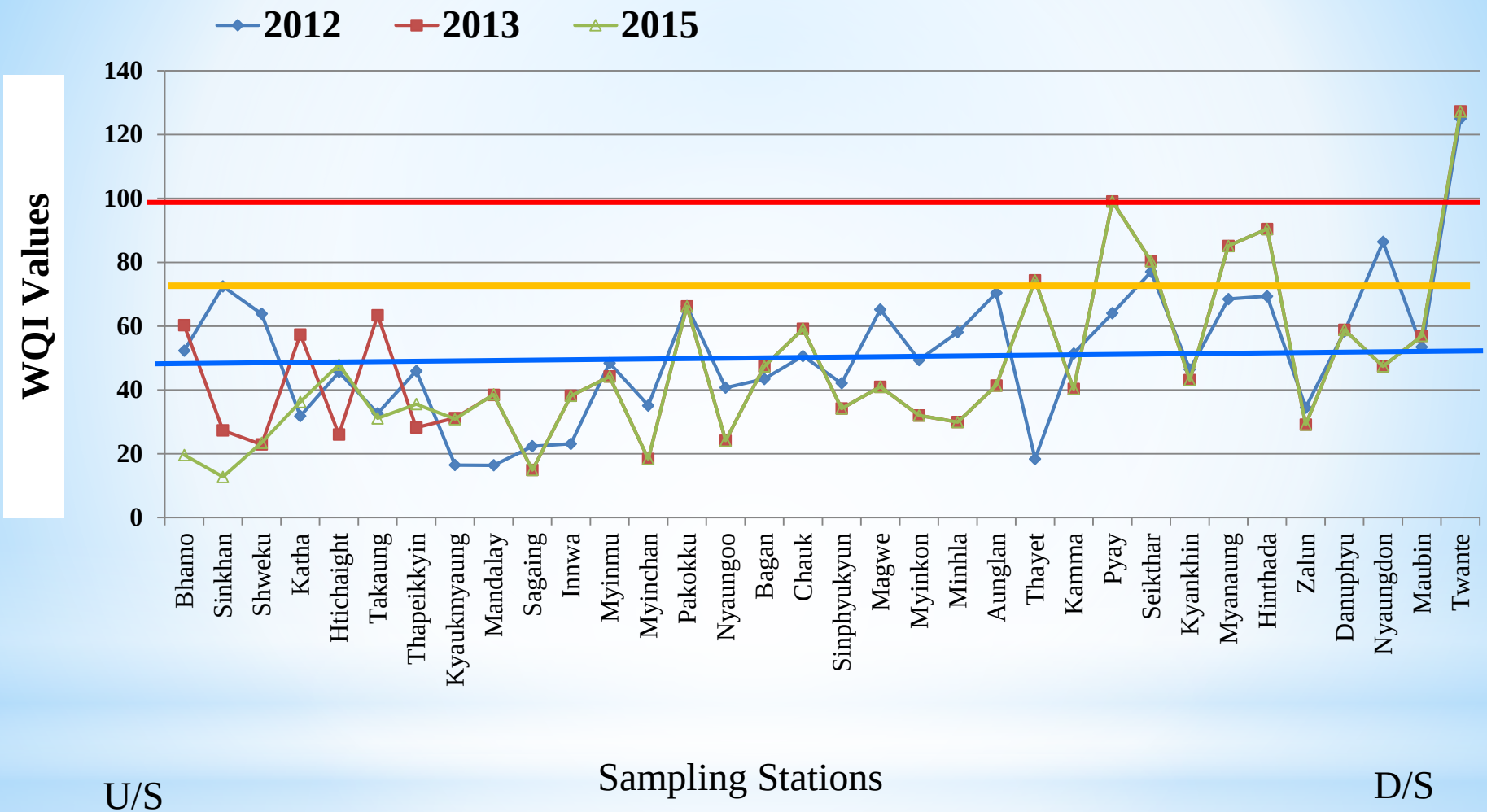


Fig.12 WQI Values of the Ayeyarwaddy River Using NWQS

Results and Discussion

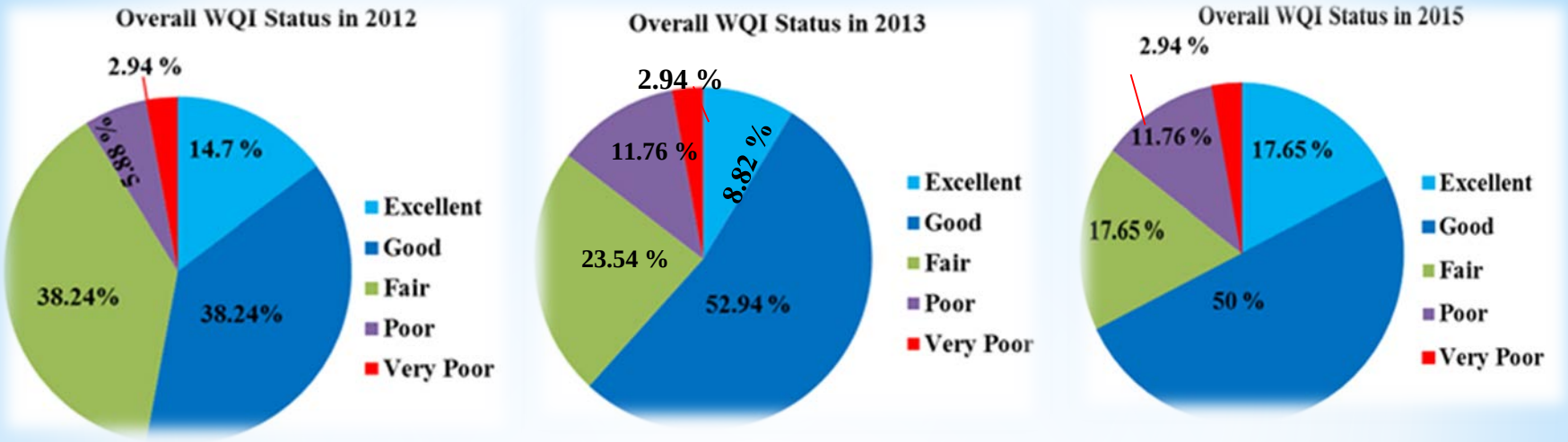


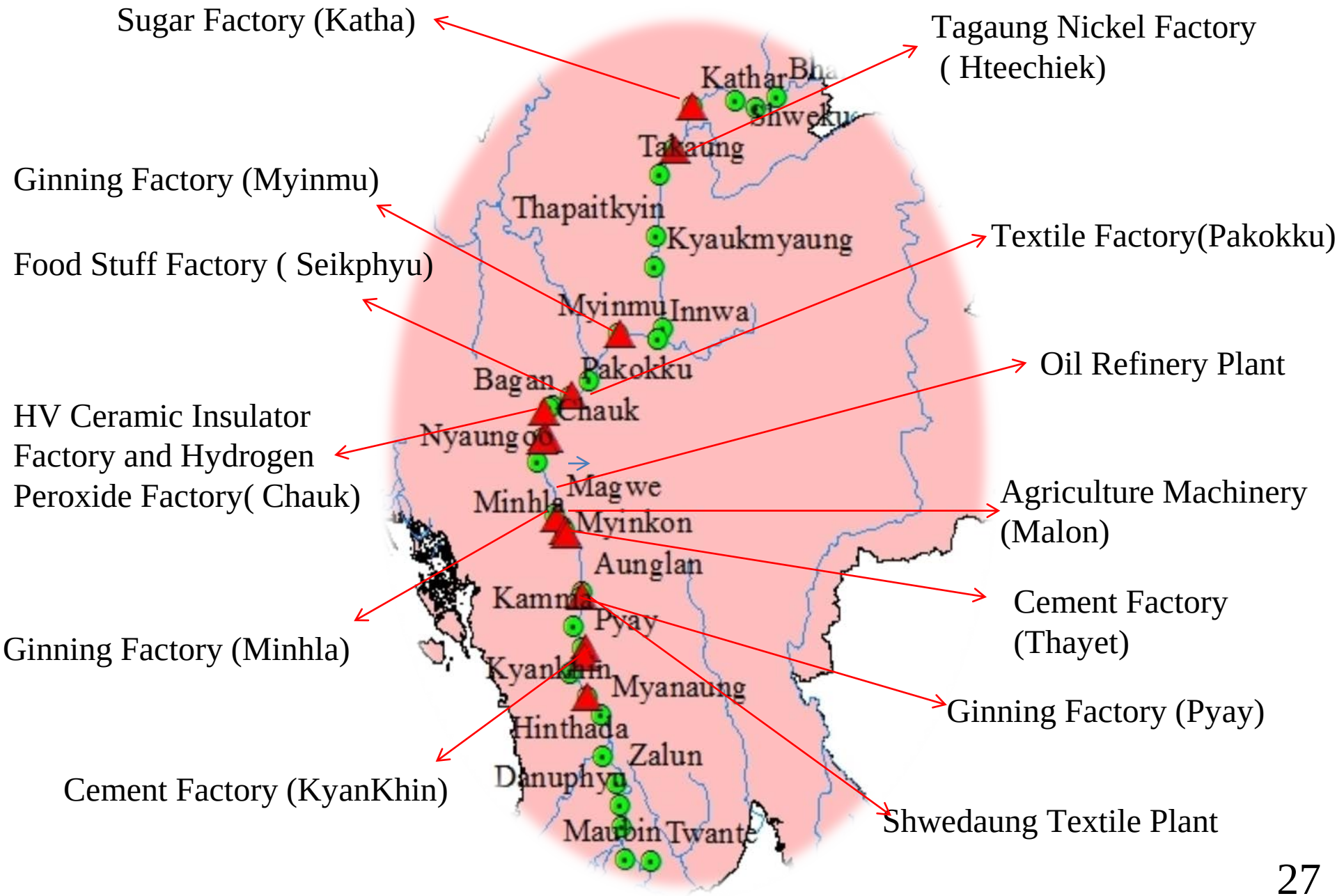
Fig. 13 WQI Categories of Samples (%) by Yearly (NWQS)

- In 2012, only 52.94 % is suitable for domestic, irrigation and industrial purpose ,38.24 % is fair for only irrigation and industrial and 8.82 % is unsuitable for irrigation.
- In 2015, more stations had excellent water quality than 2012 and 13 but
- the amount of water in poor and very poor status in 2013 &2015 is more than 2012 as well.

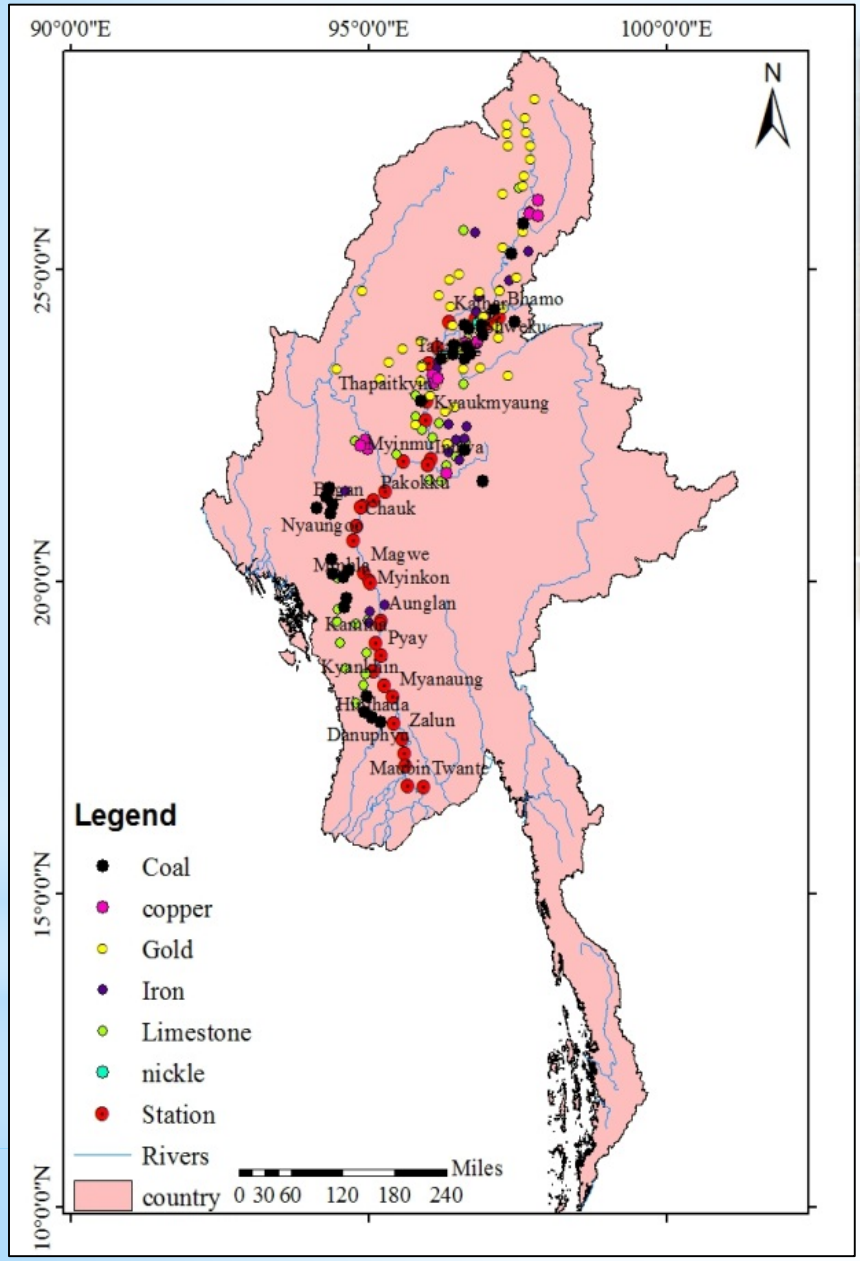
Sources of Contamination

- In Bhamo, Shweku, Myinmu, and Hinthada watersheds are extremely dominant by agricultural area. Therefore, agricultural land use is a major factor in water quality degradation in these stations
- Mandalay, Sagaing, Pyay and Myanaung watersheds are prevalent with urban and built up area. Increased runoff washes out nutrients from surfaces, eventually entering a stream.
- Katha, Htichaight, Kyaukmyaung , Myinchan, Innwa, Pakokku, Nyaungoo , Magwe, Minhla, Aunglan , Thayet and Kyankhin stations are dominant by not only agriculture but also the effluents from industries.

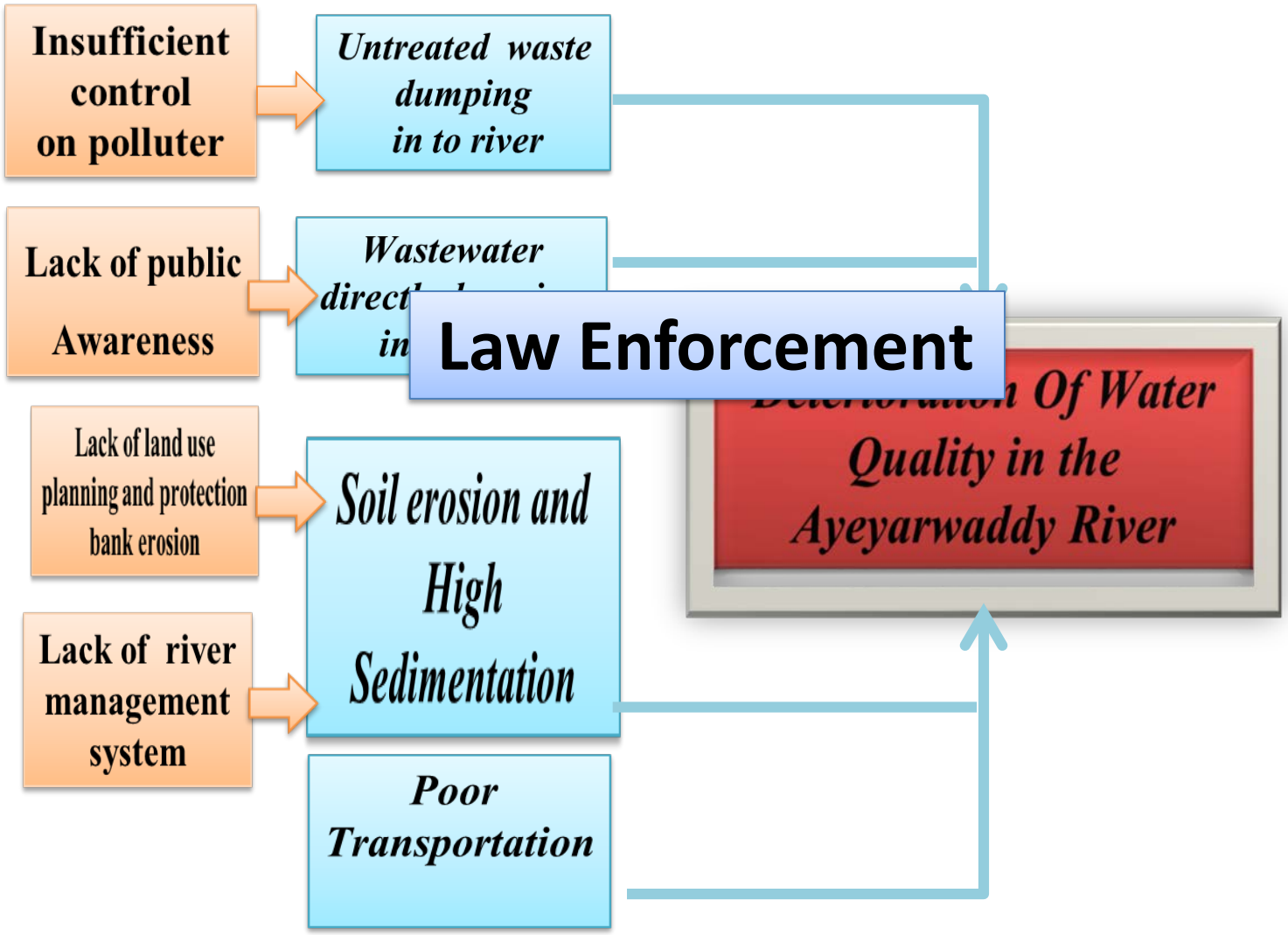
Location Map of Industries



Location Map of Mining



Causes of WQ Deterioration



Conclusion

- ✓ (WQI) is useful in assessing the overall quality of river water. It clearly shows that the Ayeyarwaddy River water is suitable for irrigation and industrial in middle ARB and the water is only fit for irrigation purpose in the Lower ARB and Delta area. However, the water quality of Twante station is very poor and it is not fit for irrigation.
- ✓ The values of turbidity, chloride and iron are higher in Pyay station
- ✓ Might be due to discharge of untreated the sewage from the industries and agriculture sector .
- ✓ The reduction of DO concentrations in Htichaight, Takaung, Thapeikkyin and Kyaukmyaung is attributed to the discharge of pollutants from industries.

Conclusion

- ✓ The nitrite concentrations in Kyankhin and Maubin are higher than the standard it is needed to monitor effluents of the cement factory in Kyankhin and the fish and prawn farms in Maubin and others.
- ✓ The ammonia comprising in Inwwa (dowmstream of the confluence of Myit Nge River), Pakukko, Nyaungoo, Chauk, Myinkon, Minhla, Aunglan, Kamma, Seikthar, Kyankhin, Myanaung, Hinthada and Twante are very high due to runoff carrying ammonia based fertilizers into the river. It is an indicator of pollution from the excessive usage of ammonia rich fertilizers. So, there should assess runoff from agriculture wastewaters.
- ✓ The hardness concentrations and iron concentrations are lower than the standard except Twante and Pyay. According to present study finding, it can be classify Ayeyarwaddy River water as soft water.

Conclusion

- ✓ Ayeyarwaddy River can be described as a river at high risk of pollution from the activities in the catchment with extensive agriculture, wastewater discharge and all mining activities contributing to the water quality of the river.
- ✓ It is necessary to increase the area of forest land, grassland, and water area and so, there should be implement land use planning in the basin.
- ✓ The main cause of deterioration in water quality at these monitoring stations was due to the high anthropogenic activities, illegal discharge of sewage and industrial effluent, lack of proper sanitation, unprotected river sites, and urban runoff.

Conclusion

- ✓ Therefore, the basin is necessary to establish the systemic land use optimization and water pollution control and the formulation of policies for coordinating the water resource exploitation and protection by state levels or region levels.
- ✓ Also wastewater treatment plants should be established with each industry with proper follow-up and the disposal of industrial waste without treatment should be stopped to save the river water from further deterioration.
- ✓ As a result, all mining operations and their mining wastes are the main sources of river water quality degradation in the upstream of the river and the high sedimentation rate of downstream stream is the impact of the mining operations in the upstream of the Ayeyarwaddy River.

Conclusion

- ✓ Although DWIR has prescribed “The Conservation of Water Resources and River Law” including the prohibitions and penalties, it is needed to be enforced.
- ✓ There is also a need of regular and detailed water quality monitoring of the Ayeyarwaddy River and the identify changes or trends in water quality over time and space, to obtain necessary information to design specific pollution prevention programs

Recommendations

1. Firstly, for future water quality monitoring, all of the water quality parameters were found to be statistically different by seasonal.
2. To improve water resources of Myanmar, there should be regularly done the monitoring of the lakes, streams and rivers and the land use planning by regional or national law.
3. The public awareness is needed to safeguard the quality of our water sources and there is a need for Myanmar to develop their own pollution load standards and guidelines for surface water.
4. Legislation already laid down should be enforced and industries registered according to the effluent they discharge. Toxic chemicals used in agriculture and industry should also be monitored.

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*Thank You