CONCLUSIONS

5.1. Conclusion

1. The available literature indicates that 'River Health' is a well established and acceptable term now. However, the method of its scientific assessment is yet evolving. Countries like Australia, China, South Korea, South Africa, Thailand, UK etc. have done appreciable works in this direction.

2. Apart from Water Quality parameters, biotic indicators, such as Algae, Macroinvertebrate and Fish are considered important to be monitored for River Health Assessment.

3. A Framework for River Health Assessment using water quality indicators divided in 5 Groups, namely Organo-Electrolytic-Bacterial (OEB), Nutrient (NT), Algae (A), Macroinvertebrate (MI) and Fish (F) has been proposed in the present study.

4. Water quality parameters have been converted into Indicator Group Scores on 0-5 scale. Indicator Group Scores have been used to develop an integrated River Health Index (RHI) on 0-100 scale as:

$$RHI = [OEB \times w1 + NT \times w2 + A \times w3 + MI \times w4 + F \times w5]$$

where OEB, NT, A, MI and F represents respective indicator group score and w1, w2, w3, w4 and w5 are weigthage for respective group of indicators.

5. Based on River Health Index (RHI), River Health Condition (RHC) has been classified as: Acceptable (RHI > 60) & Poor (RHI ≤ 60). The Acceptable Class of river health condition has further been subdivided into 'Excellent', 'Very

Good' & 'Good' classes. Similarly 'Poor' River Health Condition has been subdivided into 'Stressed', 'Over-Stressed', 'Critical' and 'Sick/Dead' classes depending on reducing RHI scale.

6. River Health Condition (RHC) has been pictorially depicted as a colored circumscribed pentagon, each sector of which represents one Indicator Group. The color of each sector of pentagon is based on Indicator Group Score and that of circumscribing pentagon is based on River Health Index (RHI).

7. The proposed Framework of River Health Assessment was first validated and explained using observed data of river Ganga near Varanasi during 2016-17 and 2017-18 for four seasons each year.

    The analyses indicate that the health of river Ganga near Varanasi varied from 'Good' to 'Critical' condition during the observation period. At C/O Assi Nala (V2), Raaj Ghat(V4) and C/O Varuna (V5), the critical parameters include COD, FC, TN and TP. Two additional parameters, one each from OEB and NT such as BOD and NH_3-N also become critical during Summer season.

8. Application of the proposed River Health Assessment Framework has been extended using observed representative data of river Ganga near six cities, namely **Rishikesh, Haridwar, Kanpur, Allahabad, Varanasi and Patna.**

9. The River Health Condition of Ganga near these cities are found as follows:

City	River Health Condition
Rishikesh	Excellent to Good
Haridwar	Very Good to Stressed
Kanpur	Stressed to Critical
Allahabad	Good to Over Stressed
Varanasi	Good to Critical
Patna	Good to Critical

10. During Post Monsoon season at upstream of all the cities (except Patna) the critical parameters are TN and TP. The increased TN and TP at the upstream of all the cities may possibly be due to surface runoff from the agricultural fields.

11. At Kanpur, COD, FC, NH_3-N, TN, and TP are critical parameters throughout the year. The River Health Condition varies from 'Stressed' to 'Critical'.

12. As Ganga reaches Allahabad, its health condition is observed to be 'Good' to 'Over Stressed'. COD, FC and TN are critical parameters throughout the year, but during Summer season NH_3-N also becomes critical at Sangam (A2) and Chattnag Ghat (A3).

13. At Patna, COD, FC and TN are critical parameters at Kali Ghat (P2) and Kangan Ghat (P3) throughout the year. The BOD and TP also become critical at these locations during Summer season.

14. Analyses indicate that for River Health Condition to be in 'Acceptable' category, water quality parameters should be preferably as given below:

OEB (i)   EC ≤ 1000 µmhos/cm

(ii)   DO > 5 mg/l

(iii)   BOD ≤ 4 mg/l

(iv)   COD ≤ 50 mg/l

(v)   FC < 1500 MPN/100ml

NT (i)   NH3-N ≤ 0.9 mg/l

(ii)   TN ≤ 1.2 mg/l

(iii)   TP ≤ 0.2 mg/l

With OEB and NT parameters within these ranges, Algal (A), Macroinvertebrate (MI) and Fish (F) Indicator Group Scores are also expected to be under 'Acceptable' category.

15. To improve the health of river Ganga at different cities, the improvement work is proposed to be carried out in two phases spread over a period of five years. A tentative phased program has also been presented.

16. The River Health Condition presented through the colored circumscribed pentagon appears to be reasonably reflecting the Water Quality & Biotic condition of riverine environment.

17. Based on color of each indicator group, causative critical water quality parameters may be identified, which may be used as tool for engineering intervention for River Health Improvement/ Restoration.

18. The proposed framework of River Health Assessment appears reasonably reflecting the health of river under Indian conditions.

19. Indicator Group Score based RHI gives clear identification of critical parameters affecting the River Health. These critical parameters may serve as useful base for River Health Restoration plan.

   With time, the proposed Framework for River Health Assessment may improve as more data becomes available, aquatic conditions can be better understood and reference values can be further refined.

5.2   Scope for Further Studies

1. In other countries, separate indices such as Riparian Vegetation Index, River Habitat Index, Hydrological Index etc. have been calculated for riverine environment. With suitable modification, similar exercise may be attempted for Indian rivers also.

2. With such separate indices, the River Health Assessment Framework may further be refined to develop an integrated River Health Index.

3. Proposed Framework of River Health Assessment may be applied to understand the River Health Condition of river Assi, Varuna, Ramganga, Kali, Gomti etc.

REFERENCES

Adakole J. A. (2001). The effect of domestic, agricultural and industrial effluents on the water quality and biota of Bindare Stream, Zaria-Nigeria. PhD Thesis, Dept. of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria.

Agouridis Carmen T., Wesley Evan T., Sanderson Tyler M. and Newton Blake L., (2015). "Aquatic Macroinvertebrates: Biological Indicators of Stream Health". Agriculture and Natural Resources Publications. https://uknowledge.uky.edu/anr_reports/175

Allan, J.D. (1995) Stream Ecology: Structure and Function of Running Waters 2nd Edition. Kluwer Academic Publishers Dordrecht, The Netherlands.

An Kwang-Guk, Seok Soon Park, Joung-Yi Shin. (2002). An evaluation of a river health using the index of biological integrity along with relations to chemical and habitat conditions. Environment International 28, 411 – 420.

Anon (2000). Australian and New Zealand guidelines for fresh and marine water quality. Volume 1. The guidelines, Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Act, Australia.

ANZECC and ARMCANZ (2000a). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, The Guidelines (Chapters 1 – 7). National Water Quality Management Strategy Paper No. 4. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Act, Australia, October.
URL:http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality_/ (accessed 18 September 2009).

ANZECC and ARMCANZ (2000b). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 2, Aquatic Ecosystems — Rationale and Background Information (Chapter 8), National Water Quality Management Strategy Paper No. 4.

Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra. URL: http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_ and_marine_water_ quality_ / volume_2 (accessed 18 September 2009).

ANZECC and ARMCANZ (2000c). Australian and New Zealand Guidelines for Fresh and Marine Water Quality: Volume 3 - Primary Industries - Rationale and Background Information. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra, October.URL:http://www.mincos.gov.au/publications/australian_and_new_zealand_guideli nes_for_fresh_and_marine _water_quality / volume_3 (accessed 18 September 2009).

ANZECC and ARMCANZ (2000d). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1, Chapter 3, Aquatic ecosystems [Online]. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Act, Australia, p. 3.3-10.

APHA (2005). Standard Methods for the Examination of Water and Wastewater. 21st Edition, American Public Health Association/American Water Works Association / Water Environment Federation, Washington DC, USA.

Askey-Doran M., Hart B., Ladson T. and Read M. (2009). Tasmanian River Condition Index South Horbart, Tasmania, Australia.

Barbour M. T., Gerritsen J., Snyder B. D, Stribling J. B. (1999). Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second ed. EPA 841-B-99-002 U.S. Environmental Protection Agency, Washington, D.C., USA, (Office of Water).

Barmuta L.A., Chessman B.C. and Hart B.T. (2002). Australian River Assessment System: Interpretation of the Outputs from AusRivAS-(Milestone Report). Land and Water Resources Research and Development Corporation.

Baruah D., Borah S., Hazarika L.P., Dutta R., Bakalial B., Biswas S. P. and Sarma, S.K. (2011). A simple diagnostic tool for measuring river health- example from a tropical snow fed river. Annals of biological research, 2(5), 432-443.

Bhardwaj R. M. (2005). Water quality monitoring in India- achievements and constraints. IWG-Env, International Work Session on Water Statistics, Vienna, Austria.

Bhargava D.S. (1983) "Use of water quality index for river classification and zoning of Ganga River", Environment Pollution Series B., England Vol.6, No. 1, pp51–67.

Biosson J. C. and Perrodin Y. (2006). Effects of road runoff on biomass and metabolic activity of periphyton in experimental streams. Journal of Hazardous Materials 132(2–3): 148–154.

Blakely Tanya J., Eikaas Hans S. & Harding J. S. (2014). The Singscore: a macroinvertebrate biotic index for assessing the health of Singapore's streams and canals. Raffles Bulletin of Zoology 62: 540–548.

Bonada, N., Prat, N., Resh, V.H., Statzner, B. (2006). Developments in aquatic insect biomonitoring: a comparative analysis of recent approaches. Annual Review of Entomology 51, 495-524.

Bond N. R., Liu W., Weng S. C., Speed R., Gippel C. J., Catford J. A., et al. (2011). Assessment of river health in the Pearl River Basin (Gui sub-catchment). Brisbane: River Health and Environmental Flow in China Project, Pearl River Water Resources Commission and International Water Centre, Guangdong province,Southern China.

Bond N., Speed R., Gippel C., Catford J., Liu Wei, Weng Shichuang, Bunn S. (2012). Assessment of River Health in the Gui River. International Water Centre, Brisbane, Queensland,Australia.

Bouguerne, A., Boudoukha, A., Benkhaled, A. & Mebarkia, A. H. 2017 Assessment of surface water quality of Ain Zada dam (Algeria) using multivariate statistical techniques. International Journal of River Basin Management 15(2), 133–143.

Brown R. M., McLelland N.I., Deininger R. A. and O'Connor M. F. (1972). "A water quality index –crashing the psychological barrier". Indicators of Environmental Quality.

Brown R.M., McClelland N.I., Deininger R.A. and Tozer R.G. (1970). A water quality index – do we dare. Water Sewage Works 117, 339–343.

Bunn S. E., Abal E. G., Smith M. J., Choy S. C., Fellows C. S., Harch B. D., et al. (2010). Integration of science and monitoring of river ecosystem health to guide investments in catchment protection and rehabilitation. Freshwater Biology, 55(Suppl. 1), 223–240.

Cairns J. and McCormick P.V. (1992). Developing an ecosystem based capability for ecological risk assessments. The Environmental Professional, 14,186-196.

Carter, J.L. and Resh, V.H. (2013). Analytical Approaches Used in Stream Benthic Macroinvertebrate Biomonitoring Programs of State Agencies in the United States. Open-File Report 2013-1129. U.S. Geological Survey, Reston, Virginia, USA.

Carter, J.L., Resh, V.H., Rosenberg, D.M., Reynoldson, T.B. (2006). Biomonitoring in North American rivers: a comparison of methods used for benthic macroinvertebrates in Canada and the United States. In: Ziglio, G., Siligardi, M., Flaim, G. (Eds.), Biological Monitoring of Rivers: Applications and Perspectives. John Wiley & Sons, New York, NY, USA, 203-228.

Chadwick J. W., Canton S. P. and Dent R. L. (1986). Recovery of Benthic Invertebrate Communities in Silver Bow Creek, Montana, Following Improved Metal Mine Wastewater Treatment. Water, Air, Soil Pollution, 28, 427–438.

Chessman B. and Jones H. (2001). Integrated monitoring of environmental flows: design report. New South Wales (NSW) Department of Land and Water Conservation, Parramatta, NSW, Australia.

URL: http://www.dwe.nsw.gov.au/water/pdf/imef_new_design_report.pdf (accessed 18 January 2010).

Chessman B., Growns I., Currey J. & Plunkett-Cole N. (1999). Predicting diatom communities at the genus level for the rapid biological assessment of rivers. Freshwater Biology, 41, 317–331.

Chutter F.M. (1998). Research on the rapid biological assessment of water quality impacts in streams and rivers. WRC Report No 422/1/98. Water Research Commission, Pretoria, South Africa.

Clarke Ralph T., Wright John F., Furse Mike T. (2003). RIVPACS models for predicting the expected macroinvertebrate fauna and assessing the ecological quality of rivers. Ecological Modelling 160, 219-233.

Connell J. (1974). Ecology: Field Experiments in Marine Ecology. In Experimental Marine Biology; Mariscal, R., Ed.; Academic Press, New York, NY, USA, pp 21–54.

Coste in CEMAGREF (1982). Etude de Méthodes Biologiques Quantitatives d'Appreciation de la Qualité des Eaux . Rapport Q.E. Lyon-A.F.B. Rhône-Mediterrannée-Corse. CEMAGREPH, Paris, France.

Covich A. P., Palmer M. A. and Crowl T. A. (1999). The Role of Benthic Invertebrate Species in Freshwater Ecosystems. BioScience, 49, 119– 127.

CPCB ADSORBS/3: 1978–1979. Scheme for Zoning and Classification of Indian Rivers: Estuaries and Coastal Waters, New Delhi, India.

CPCB (2002). 'Water Quality Status of Yamuna River, Assessment and Development of River Basin'. CPCB Report. ADSORBS/32: 1999–2000, New Delhi, India..

CPCB (Feb 2002). "Water Quality Criteria and Goals", New Delhi, India..

CPCB (2013). Status of Water Quality in India 2011. Ministry of Environment & Forests. Monitoring of Indian National Aquatic Resources. Series: MINARS/ 35/ 2013-14, New Delhi, India.

CPCB (Dec 2015). A Concept and Plan "Conservation of Water Quality of Ganga: A Segmental Approach" Proposed primary water criteria for bathing water, New Delhi, India.

CPCB (2017). Biological Health of River Ganga. Central Pollution Control Board Ministry of Environment, Forest & Climate Change, Govt. of India Parivesh Bhawan, East Arjun Nagar, Delhi, India.

Das M. K., Sharma A. P., Vass K. K., Tyagi R. K., Suresh V. R., Naskar M. and Akolkar A. B. (2013). Fish diversity, community structure and ecological integrity of the tropical River Ganges, India, Aquatic Ecosystem Health & Management, 16:4, 395-407.

Das S. K., Biswas D. and Roy S. (2007). Phytoplanktonic community of organically polluted tropical reservoirs in Eastern India. Chinese Journal of Applied Environmental Biology, 13(4), 449-453.

Dash, S., Borah, S. S. and Kalamdhad A. (2018). Monitoring and assessment of Deepor Beel water quality using multivariate statistical tools. Water Practice & Technology Vol 13 No 4 893 doi: 10.2166/wpt.2018.098

Davies P. E., Harris A. J. H., Hillman T. J., and Walker K. F. (2010). The Sustainable Rivers Audit: Assessing river health in the Murray-Darling Basin, Australia. Marine and Freshwater Research, 61, 764–777.

De Zwart D. and R. C. Trivedi (1994). Manual on Integrated Water Quality Evaluation (Report 802023003). National Institute of Public Health and Environmental Protection (RIVM), Bilthoven, The Netherlands.

Dong Zheren (2005). River health connotation. China water resources, Beijing, China, 4:15-18.

Durrand J. R. and Leveque C. (1981). Flore et fauna Aqua tyries De l' Afrque Saholo-Sou damienne edition de l' office de la Recherche Scientific et Technique actre-marcollection initiatins. Documentations Technique No. 45 Paris, France.

Dwivedi A. C., Mishra A. S., Mayank P. and Tiwari A. (2016). Persistence and Structure of the Fish Assemblage from the Ganga River (Kanpur to Varanasi section), India. Journal of Geography & Natural Disasters 6: 159. doi:10.4172/2167-0587.1000159

EHMP (2010). Ecosystem Health Monitoring Program 2008–09, Annual Technical Report, South East Queensland Healthy Waterways Partnership, Brisbane, Queensland, Australia.

Etchanchu D. Probst J.L. (2006). Evolution of the chemical composition of the Garonne River water during the period 1971-1984. Journal of hydrologique Science, 33(3), 243-256.

Evans Lisa. J. and Norris R. H. (1997). Prediction of benthic macroinvertebrate composition using microhabitat characteristics derived from stereo photography. Freshwater biology, 37, 621-633.

Fairweather P. G. (1999). State of environment indicators of 'river health' exploring the metaphor. Freshwater Biology, 41:211-220.

Faith D. P., Minchin P. R. and Belbin L. (1987). Compositional dissimilarity as a robust measure of ecological distance. Vegetation, 69: 57–68.

Flotemersch J. E., Stribling J. B. & Paul M. J. (2006). Concepts and approaches for the bioassessment of nonwadeable streams and rivers. Washington, DC, USA; U.S. Environmental Protection Agency

Frey D. G. (1977). Biological integrity of water – An historical approach. In Ballantine, R.K. and Guarraia, L.J. (eds), The Integrity of Water. Proceedings of a Symposium, March 10–12, 1975, U.S. Environmental Protection Agency, Washington, D.C., USA

Genter R. B. and Lehman R. M. (2000). Metal toxicity inferred from algal population density, heterotrophic substrate use, and fatty acid profile in a small stream. Environmental Toxicology and Chemistry 19(4): 869–878.

Gerber A. and Gabriel M. J. M. (2002). Aquatic invertebrates of South African Rivers. Volume 1 and II. Field Guide. Institute for Water quality studies, Department of Water Affairs and Forestry, Pretoria.

Gippel C. J. (2010). River health monitoring, assessment and applications. International Water Centre, Brisbane, Queensland, Australia.

Gippel C. J. and Speed R. (2010). River health assessment framework: Including monitoring, assessment and applications: Australia-China Environment Development Partnership, River Health and Environmental Flow in China. Brisbane, Queensland, Australia: International Water Centre.

Gippel C. J., Jiang X. H. Fu X. F., Liu X. Q., Chen L., Wang H. Z., et al. (2012). Assessment of river health in the lower Yellow River. Australia-China Environment Development Partnership, River Health and Environmental Flow in China. Brisbane: Yellow River Conservancy Commission and International Water Centre.

Gippel C., Zhang Y., Qu X. D., Bond N., Kong W. J., Leigh C., … Meng W. (2017). Design of a National River Health Assessment Program for China. Decision Making in Water Resources Policy and Management, 321–339.doi:10.1016/b978-0-12-810523-8.00019-7

Goel P. N., Khatavkar A. Y., Kulkarni A. Y. and Trivedy R. K. (1986). Limnological studies of a few freshwater bodies in southwestern Maharasthra with special reference to their chemistry and pollution. Poll. Res. 5 (2): 79-84.

Goldar B., and Banerjee N., (2004). Impact of informal regulation of pollution on water quality in rivers in India. J. Environ. Manage. 73, 117-130. https://doi.org/10.1016/j.jenvman.2004.06.008

Gonza´lez-Oreja, J. A. and Saiz-Salinas J. I. (1998). Exploring the Relationships between Abiotic Variables and Benthic Community Structure in a Polluted Estuarine System. Water Res., 32, 3799–3807.

Gordon N. D., McMahon T. A., Finlayson B. L., Gippel C. J. and Nathan R. J. (2004). Stream Hydrology: An Introduction for Ecologists. 2nd Edition. John Wiley & Sons, Chichester, UK.

Gore J. A. (Ed) (1985). The restoration of Rivers and Streams, 280 pp Butterworth, Stoneham.

GRBMP (2014). Hydrological Flow Health Assessment of the River Ganga. Indian Institutes of Technology Report Code: 056_GBP_IIT_WRM_ANL_01_Ver_1 Jun 2014.

GRBMP (2015). Ganga River Basin Management Plan. Main Plan Document. Consortium of 7 "Indian Institute of Technologys" (IITs).

Griffith M. B., Hill B. H., McCormick F. H., Kaufmann P. R., Herlihy A. T. & Selle A. R. (2005). 'Comparative applications of indices of biotic integrity based on periphyton, macroinvertebrates, and fish to southern Rocky Mountain streams', Ecological Indicators, 5, 117–136.

Guillaud J.F. and Bouriel L. (2007). Concentration-flow and time evolution of the nitrate I 25 rivers in Brittany (France). Journal of water science, 20(2), 213-226.

Gunale V. R. and Balakrishnan M. S. (1981). Biomonitoring of eutrophication in the Pavana, Mula & Mutha rivers flowing through Poona. Indian Journal of Environmental Health, 23, 316-322.

Guo Wenxian., Xia Ziqiang., Wang Hongxiang. (2009). Connotation and Evaluation Indicators System of River Health. In Changkuan Zhang, Hongwu Tang, Advances in Water Resources and Hydraulic Engineering. Proceedings of 16th IAHR APD Congress and 3rd Symposium of IAHR-ISHS. Volume 2, pp. 423-428, Tsinghua University Press, Beijing, China.

Gurjar Suresh Kr. and Tare Vinod. (2019). Spatial-temporal assessment of water quality and assimilative capacity of river Ramganga, a tributary of Ganga using multivariate analysis and QUEL2K. Journal of Cleaner Production, 222, 550-564.

Harkins R. D. (1974). "An index number system for rating water quality" J. Water Pollution Control Fed., 46, (7), 588.

Harris J. H. (1995). The use of fish in ecological assessments. Austral Ecology 20, 65-80.

Haskell B. D., Norton B. G. and Costanza R. (1992). What is ecosystem health and why should we worry about it? Ecosystem Health: New Goals for Environmental Management (Eds R. Costanza B.G. Norton and B.D. Haskell),3-20. Island Press, Washington, DC, USA.

Hawkes H. A. (1979). Invertebrates as indicators of river water quality. In: James, A., Evision L. (Eds.), Biological Indicators of Water Quality. John Wiley and Sons, Chichester, UK.

Hellawell J. M. (1986). Biological Indicators of Freshwater Pollution and Environmental Management. Elsevier, London, UK, 546.

Horton R. K. (1965) "An index number system for rating water quality". Journal of. Water Pollution and Control Fed., 37, (3), 300–306.

Hruby T. (1987). Using similarity measures in benthic impact assessments. Environmental Monitoring and Assessment, 8: 163–180.

Hu H. J. and Wei Y. X. (2006). The freshwater algae of China, Beijing, China: Science Press.

Huaibin Wei. and Jianping Yuan. (2014). Research on theory and method of river health assessment. The Open Cybernetics & Systemics Journal, 8, 1166-1174.

Huston, M. (1979) A General Hypothesis of Species Diversity. Am. Nat., 113, 81.

ISC (2006). Index of Stream Condition: User's Manual, 2nd ed. Department of Sustainability and Environment, Victoria, Australia. Available:http://www.water.vic.gov.au/data/assets/pdf_file/0003/9921/ISC Users Manual 2ndEdition01.pdf [Accessed 2012 14 November].

Jafari N. G. and Gunale Y. R. (2006). Hydrobiological study of algae of an urban freshwater river. Journal of Applied Science and Environment Management, 10(2), 153 - 158.   http://www.ajol.info/index.php/jasem/article/viewFile/43697/27219

Jain, S. K. and Singh, V. P. (2006). River Basin Planning and Management: In Water Resources Systems Planning and Management. Elsevier 2006, p. 788.

Jha, R. and Singh, V.P. (2008). Evaluation of Riverwater Quality by Entropy. KSCE Journal of Civil Engg., 12, (1), 61-69. DOI 10.1007/s12205-008-8061-3

Johnson M. J., Giller P. S., O'halloran J., O'gorman K. and Gallaher M. B. (2005). A novel approach to assess the impact of landuse activity on chemical and biological parameters in river catchments. Freshwater Biology 50, 1273-1289.

Joshi S. (2013). Ecological Quality Index: standardized method for judging the ecological health of rivers and lakes. SERI news, Vol.7, No.8. Assessed on 19/Sept/2015. http://seriecotech.com/blog/?p=377>.

Kallis G. and Butler D. (2001). The EU water framework directive: measures and implications. Water Policy 3: 125-142.

Kannan N, Aavudai Anandhi and Jaehak Jeong (2018). Estimation of stream health using flow-based indices. Hydrology, 5, 20; doi:10.3390/hydrology5010020.

Karr J. R. (1981). Assessment of biotic integrity using fish communities. Fisheries, 6, 21–27.

Karr J. R. (1991). Biological integrity: a long-neglected aspect of water resource management. Ecological Applications, 1, 66–84.

Karr J. R. (1999). Defining and measuring river health. Freshwater Biology 41, 221-234.

Karr J. R. and Chu E.W (1999). Restoring Life in Running Waters: Better Biological Monitoring. Island Press, Washington, D.C., USA.

Karr J. R. and Chu E. W. (2000). Sustaining living rivers. Hydrobiologia 422/423: 1-14.

Karr J. R., Fausch K. D., Angermeier P. L., Yant P. R. and Schlosser I. J. (1986) Assessment of biological integrity in running water: a method and its rationale. Illinois Natural History Survey, Special Publication Number 5: 1-28. Urbana, IL, USA.

Kay W. R., Smith M. J., Pinder A. M., McRac J. M., Davis J. A. and Halse S. A. (1999). Patterns of distribution of macroinvertebrate families in rivers of north western Australia. Freshwater Biology, 41, 299-316.

Kazmi A. A., Bhatia A., Shaida A., Sharma M., Starkl M. and Trivedi R. C. (2013). A short screening study on water quality of Indian rivers and lakes. Resour. Soc., 33, (3), 28-33.

Kerans B. L. and Karr J. R. (1994). A benthic index of biotic integrity (B-IBI) for rivers of the Tennessee Valley. Ecological Applications, 4, 768-785.

Kerkhoff (2010). Measuring biodiversity of ecological communities. Ecology lab, Biology 229. http://biology.kenyon.edu/courses/biol229/diversity.pdf

Kim Jung Jae., Atique Usman.., and An Kwang-Guk. (2019). Long-Term Ecological Health Assessment of a Restored Urban Stream Based on Chemical Water Quality, Physical Habitat Conditions and Biological Integrity. Water, 11, 114; doi:10.3390/w11010114

Kingsford R. T. (1999). Aerial survey of water birds on wetlands as a measure of river and flood plain health. Freshwater Biology, 41, 425-438.

Kleynhans C. J., Louw M. D., Thirion C., Rossouw N. J. and Rowntree K. (2005). River EcoClassification: Manual for EcoStatus determination (Version 1).Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. KV 168/05

Ladson A. R. and White L. J. (1999). Measuring stream condition. River Management: the Australasian Experience (Eds S.O. Brizga and B.L. Finlayson). Wiley, New York, NY, USA.

Ladson A. R., White L. J., Doolan J. A., Finlayson B. L., Hart, B. T., Lake P. S. and Tilleard J. W. (1999). Development and testing of an Index of Stream Condition for waterway management in Australia. Freshwater Biology 41: 453-468.

Leigh C., Qu X., Zhang Y., Kong W., Meng W., Hanington P., Speed R., Gippel C., Bond N., Catford J., Bunn S. and Close P. (2012). Assessment of River Health in the Liao River Basin (Taizi Subcatchment) International Water Centre, Brisbane, Australia.

Li L, Binghui Z., Lusan L. (2010). Biomonitoring and Bioindicators Used for River Ecosystems: Definitions, Approaches and Trends. International Society for Environmental Information Sciences 2010 Annual Conference (ISEIS). Procedia Environmental Sciences 2, 1510–1524.

Linke S., Norris R. H., Faith D. P. and Stockwell D. (2005). ANNA: A new prediction method for bioassessment programs. Freshwater Biology 50, 147–158.

Liou S. M., Lo S. L., Wang S. H. (2004). A generalized water quality index for Taiwan. Environ. Monit. Assess. 96 (1), 35–52.

Liu C. and Liu X. (2009). Healthy river and its indication, criteria and standards. Journal of Geographical Sciences, 19(1), 3-11.
DOI: 10.1007/s11442-009-0003-6

Liu X. and Zhang Y. (2006). Essence and indicators of the healthy Yellow River. Journal of Hydraulic Engineering 37:649-654.

Liu X. Q., Gippel C. J., Wang H. Z., Leigh C. and Jiang X. H. (2016). Assessment of the ecological health of heavily utilized, large lowland rivers: Example of the lower Yellow River, China. Limnology:18, (pp. 17–29). http://dx.doi.org/10.1007/s10201-016-0484-9.

Lu L. (2005). The Relationship between Soft-Bottom Macrobenthic Communities and Environmental Variables in Singaporean Waters. Mar. Pollution Bull., 51, 1034–1040.

Marchant R., Hirst A., Norris R. and Metzeling L. (1999). Classification of macroinvertebrate communities across drainage basins in Victoria, Australia: consequences of sampling on a broad spatial scale for predictive modeling. Freshwater Biology, 41, 253-268.

MDBC (Murray-Darling Basin Commission) (2003). Proposal for Investment, An Implementation Program of Structural and Operational Works and Measures (2003/04 to 2005/06). The Living Murray Initiative, July.
URL: http://www.mdbc.gov.au/__data/page/1482/proposal_investment.pdf (accessed 18 September 2009).

Meng Wei, Zhang Nan, Zhang Yuan, Zheng Binghui (2009). Integrated assessment of river health based on water quality, aquatic life and physical habitat. Journal of Environmental Sciences, 21, 1017-1027.

MEP (2008). Ministry of Environmental Protection, Report on the State of the Environment in China 2006, Ministry of Environmental Protection, People's Republic of China. http://english.mep.gov.cn/standards_reports/.

Merritt R. W. and Cummins K. W. (1996). An introduction to the aquatic insects of North American, 3rd edition Dubuque, J. O: Kendall-Hunt, IOWA.

Metcalfe-Smith J. L. (1996). Biological water quality assessment of rivers: use of macroinvertebrate communities. In Petts, G. and Calow, P. (eds) River Restoration, Blackwell Science, Oxford, 17-43.

Meybeck M., Chapman D. and Helmer R. (1989). Global Freshwater Quality. A First Assessment. Published on behalf of WHO and UNEP by Blackwell Reference, Oxford, 306.

Meyer Judy L. (1997). Stream health: incorporating the human dimension to advance stream ecology. J. N. Am. Benthol. Soc., 16(2):439-447.

Mophin-Kani K. and Murugesan A. G. (2011). Evaluation and Classification of Water Quality of Perennial River Tamirabarani through Aggregation of Water Quality Index. IJEP Vol.1 No.5, 24-33.

MoWR (Ministry of Water Resources, Govt. of India) (2014). "Ganga Basin – Version 2.0".

Munyika S., Kongo V., Kimwaga R. (2015). River health assessment using macroinvertebrates and water quality parameters: a case of the orange river in Namibia, Physics and Chemistry of the Earth (2015), doi: http://dx.doi.org/10.1016/j.pce.2015.01.001

Nandan S. N. and Patel R. J. (1986). Assessment of water quality of Vishwamitra river by algal analysis. Indian J. Environ. Health, 29(2), 160-161.

National Research Council (1977). Analytical Studies for the U.S. Environmental Protection Agency, Vol. IV. Environmental Monitoring. Report of the Study Group on Environmental Monitoring. National Academy of Sciences, Washington, DC., USA; p. 13. https://doi.org/10.17226/20330.

National Water Commission (2007). Australian Water Resources 2005. A baseline assessment of water resources for the National Water Initiative, Level 2 Assessment, River and Wetland Health Theme, Assessment of River and Wetland Health: An Australian Snapshot. Australian Government, Canberra, ACT, Australia, May.

URL: http://www.water.gov.au/publications/RWH_FARWH_Snapshot_090507.pdf (accessed 18 September 2009).

Needham J. G. and Needham P. R. (1969). A guide to the study of fresh water biology Holden – Day Inc. Sanfranhisco, 108. Ruttener, F: 1953. Fundamentals of Limnology. Publ. E.E.J. Unic. Pres. Toronto, ON Canada.

Norris R. H., Dyer F., Hairsine Kennard, Mark Linke, Simon Merrin, Linda Read, Arthur Robinson, Wayne Ryan, Chris Wilkinson Scott, Williams D., (2007). Assessment of River and Wetland Health: A Framework for Comparative Assessment of the Ecological Condition of Australian Rivers and Wetlands. National Water Commision, Canberra, ACT, Australia.

Norris R. H. and Hawkins C. P. (2000). Monitoring river health. Hydrobiologia, 435, 5-17.

Norris R. H., Liston P. Davies N., Dyer F., Linke S., Prosser I. and Young W. (2001). Snapshot of the Murray-Darling Basin River Condition. Report by Cooperative Research

Centre for Freshwater Ecology, University of Canberra and CSIRO Land and Water to Murray-Darling Basin Commission, Canberra, ACT, Australia.

Norris R. H. and Norris K. R. (1995). The need for biological assessment of water quality: Australian perspective. Australian Journal of Ecology, 20, 1-6.

Norris R. H. and Thoms M. C. (1999). What is river health? Freshwater biology 41, 197-209.

Ojha C. S. P. and Thakur A. K. (2010). River Bank Filtration in North India. ASCE Conf. Proc. Doi:10.1061/41114(371)87 published The June 15, World Environmental and Water Resources Congress: Challenge of Change, Providence, Rhode Island, U.S.A., 16–20 May, 2010, 782-791.

Omernik J. M. (1987). Ecoregions of the conterminous United States. Annals of the Association of American Geographers 77(1): 118-125.

Palmer C. M. (1969). Composite rating of algae tolerating organic pollution. Journal of Phycology, 5: 78-82.

Parsons M. and Norris R. H. (1996). The effect of habitat specific sampling on biological assessment of water quality using a predictive model. Freshwater Biology, 36, 419-434.

Parsons M., Thoms M. and Norris R. (2002). Australian River Assessment System: Review of Physical River Assessment Methods — A Biological Perspective. Monitoring River Heath Initiative Technical Report Number 21. Commonwealth of Australia and University of Canberra. Environment Australia, Canberra, ACT, Australia.

Patrick R. (1965). Algae as indicator of pollution. In biological problems in water pollution. 3rd Seminar Bot. A. Tuft. Sanitory Eng. Centre Cincinati, Ohio, USA.

Pearsall W. H. (1932). Phytoplankton in the English lakes II. Ecol. 22: 241-262.

Pearson T. and Rosenberg R. (1978). Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment. Oceanog. Mar. Biol.: Annu. Rev., 16, 229–311.

Pennak W. P. (1978). Freshwater invertebrates of the United States. Oxford: Ronald.

Pennak R. W. (1989). Fresh-water invertebrates of the United States: Protozoa to Mollusca. 3rd. ed. John Wiley and Sons, New York, NY, USA.

Peter D., Harris J., Hillman T. and Walker K. (2008). SRA Report 1: A Report on the Ecological Health of Rivers in the Murray- Darling Basin, 2004-2007. Canberra, ACT, Australia.: Prepared by the Independent Sustainable Rivers Audit Group for the Murray-Darling Basin Ministerial Council.

Peterson R. C. (1992). The RCE: a riparian, channel, and environmental inventory for small streams in the agriculture landscape. Freshwater Biology. 1992, 27(2): 29-306.

Pinto U. and Maheshwari B. (2011). River health assessment in peri-urban landscapes: An application of multivariate analysis to identify the key variables. Water research 45, 3915-3924.

Pinto U. and Maheshwari B. (2014). A framework for assessing river health in peri-urban landscapes. Ecohydrology & Hydrobiology 14, 121–131.

Plafkin J. L., Barbour M. T., Porter K. D., Gross S. K., and Hughes R. M. (1989). Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/444/4-89-001. U.S. Environmental Protection Agency, Washington, DC, USA.

Prati L., Pavanello R. and Pesarin F. (1971). "Assessment of surface water quality by a single index of pollution, Water Res..5, 741–75.

Qu, X. D., Zhang H. P., Zhang M., Liu M., Yu Y., Xie Y., et al. (2016). Application of multiple biological indices for river health assessment in northeastern China. International Journal of Limnology, 52, 75–89.

Rai U. N., Dubey S., Shukla O. P., Dwivedi S. & Tripathi R. D. (2008). Screening & identification of early warning algal species for metal contamination in fresh water bodies polluted from point & non-point sources. Environmental Monitoring Assessment, 144, 469-481.

Rapport D. J. (1989). What constitutes ecosystem health? Perspectives in Biology and Medicine, 33, 120-132.

Rapport D. J. (1991). Myths in the foundations of economics and ecology. Biological Journal of the Linnean Society 44:185-202.

Ratnasabapathy M. (1975). Biological aspects of Wardieburn sewage oxidation pond. Malaysian Science, 3(a), 75-87.

Reavie E. D., Jicha T. M., Angradi T. R., Bolgrien D. W., Hill B. H. (2010) Algal Assemblages for Large River Monitoring: Comparison Among Biovolume, Absolute and Relative Abundance Metrics. Ecol. Indic., 10, 167–177.

Regier H. A. (1993). The notion of natural and cultural integrity. Ecological Integrity and the Management of Ecosystems (Eds S. Woodley J. Kay and G. Francis), pp. 3-18. St Lucie Press, Delray Beach, FL, USA.

Resh V. H., Myer M. J. and Hannaford M. J. (1996). Macroinvertebrates as biotic indicators of environmental quality. Methods in Stream Ecology (Eds. F.R. Hauer and G.A. Lamberti), pp 647-667. Academic Press, San Diego, CA, USA.

Reynoldson T. B., Norris R. H., Resh V. H., Day K. E. and Rosenberg D. M. (1997). The reference condition: a comparison of multimetric and multivariate approaches to assess water-quality impairment using benthic macroinvertebrates. Journal of the North American Benthological Society, 16, 833-852.

Rosenberg D. M. and Resh V. H. (1993). Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman & Hall, London, UK;. 488.

Said A., Stevens D. K., Sehlke G. (2004). An Innovative Index for Evaluating Water Quality in Streams. Environmental Management, 34, (3), 406–414.

Sallenave R. (2015). Stream biomonitoring using benthic invertebrates. Circular 677. http://aces.nmsu.edu/pubs/_circulars/CR677.pdf New Mexico State University 4 Cooperative Extension Service. College of Agricultural, Consumer and Environmental Sciences.

Sanap R. R. (2007). Hydrobiological studies of Godavari River up to Nandur-Madhmeshwar dam, Dist Nashik, Maharashtra. Ph. D. Thesis, University of Pune, Pune, India.

Sargaonkar A. and Deshpande V. (2003). Development of an overall index of pollution for surfacewater based on a general classification scheme in Indian context. Environmental Monitoring and Assessment 89: 43–67.

Schofield N. J. and Davies P. E. (2007). "Measuring the Health of our Rivers." Australian Government Dept. of Sustainability, Environment, Water, Population and Communities, reproduced from the journal "Water." May/June 1996.

Sharma S. and Reddy A. S. (2013). Development of Water Quality Indices for Designated Best Uses of Surface Water Body. International Journal of Engineering Science and Innovative Technology (IJESIT), 2, (5), 82-93.

Sharma S., Dawar, B. and Barkale S. (2014). Biomonitoring a biological approach to water quality management. Elixir Bio Diver. 66 (2014) 20635-20638.

Shinde Victor R. and Babel Mukand S. (2018). Manual on framework for river health assessment in Thailand. Bangkok, Thailand: Asian Institute of Technology (AIT). 22p.

Simon T. D. and Lyons J. (1995). Application of the index of biotic integrity to evaluate water resource integrity in fresh water ecosystems. In: Davis, W. S. & T. D. Simon (eds), Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publ., Chelsea, Michigan, USA: 243–260.

Simpson J. C. and Norris R. H. (2000). Biological assessment of river quality: development of AUSRIVAS models and outputs. In Wright J. F., D. W. Sutcliffe & M. T. Furse (eds), Assessing the Biological Quality of Fresh Waters: RIVPACS and other techniques. Freshwat. Biol. Ass. Ambleside, U.K.: 125–142.

Simpson J., Norris R., Barmuta L. and Blackman P. (1996). Australian River Assessment System: National River Health Program Predictive Model Manual. URL http://ausrivas.canberra.edu.au/ausrivas.

Simpson J., Norris R., Wright J., Sutcliffe D., Furse M. (2000). Biological assessment of river quality: development of AUSRIVAS models and outputs. Assessing the biological quality of fresh waters: RIVPACS and other techniques. In: Proceedings of an International Workshop held in Oxford, UK, 16–18 September, Freshwater Biological Association (FBA), 125–142.

Singh K. P., Malik A., Mohan D., Sinha S. (2004). Multivariate statistical techniques for the evaluation of spatial and temporal variations in water quality of Gomti River (India) - a case study. Water Res. 38, 3980e3992. https://doi.org/10.1016/j. watres.2004.06.011.

Singh K. P., Malik A. and Sinha S. (2005). Water quality assessment and apportionment of pollution sources of Gomti river (India) using multivariate statistical techniques - a case study. Anal. Chim. Acta 538, 355-374. https://doi.org/10.1016/j. aca.2005.02.006

Singh, P. K. and Saxena, S. (2018).Towards developing a river health index. Ecological Indicators, 85, 999–1011.

Singh, K. R., Dutta, R. · Kalamdhad, A. S. and Kumar, B. (2019). Information entropy as a tool in surface water quality assessment. Environmental Earth Sciences (2019) 78:15. https://doi.org/10.1007/s12665-018-7998-x

Sinha R., Mohanta H., Jain V. and Tandon S. K. (2017). Geomorphic diversity as a river management tool and its application to the Ganga River, India. River Resources Application, 1–21. DOI: 10.1002/rra.3154

Sladecek V. (1979). Continental systems for the assessment of river water quality. In: James, A., Evison L. (Eds.), Biological Indicators of Water Quality. John Wiley & Sons, Chichester, UK.

Smith M. J., Kay W. R. and Edward D. H. D. (1999). AusRivAS: using macroinvertebrates to assess ecological condition of rivers in Western Australia. Freshwater Biology 41: 269–282.

Southerland M. T. and Stribling J. B. (1995). Status of biological criteria development and implementation. In Davis, W. W. & T. P. Simon (eds), Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, Florida, USA: 81–96.

Sprague J., Elson P., Saunders R. (1965). Sublethal Copper-Zinc Pollution in a Salmon River—A Field and Laboratory Study. Int. J. Air Water Pollution, 9, 531–543.

Stockwell D. and Faith D. P. (1996). Investigation of alternative approaches to linking habitat variables with site classification in a RIVPACS model-Final Report. Land & Water Resources Reseach & Development Corporation, Canberra, ACT, Australia.

Swamee P. K and Tyagi A. (2000). Describing water quality with aggregate index. J. Environ Engg. ASCE, 126, (5), 451-455.

Tan X., Ma P., Bunn S. E. and Zhang Q. (2015). Development of a bentic diatom index of biotic integrity (BD-IBI) for ecosystem health assessment of human dominant subtropical rivers, China. Journal of Environmental management, 151, 286-294.

Tare V., Yadav A.V.S., and Bose P. (2003). Analysis of photosynthetic activity in the most polluted stretch of river Ganga. Water Res. 37, 67-77. https://doi.org/10.1016/ S0043-1354(01)00385-2.

Tippler C., Wright I. A and Hanlon A. (2012). Development of regional water quality and catchment guidelines for the conservation of aquatic ecosystems: a case study from the Georges River catchment, in Grove, J.R and Rutherford, I.D (eds). Proceedings of the 6th

Australian Stream Management Conference, Managing for Extremes, 6-8 February, 2012, Canberra, Australian Capital Territory, Australia. Published by the River Basin Management Society, 519-526.

Tittizer T.T. and Koth P. (1979). Possibilities and limitations of biological methods of water analysis. In: James A., Evison L. (Eds.), Biological Indicators of Water Quality. John Wiley and Sons, Chichester, UK.

Tonapi G. T. (1980). Fresh water animals of India-an Ecological approach. Oxford and IBH Publishing Co. New Delhi, India; 341.

Torrisi M, Scuri S. Dell'Uomo A. and Cocchioni M. (2010). 'Comparative monitoring by means of diatoms, macroinvertebrates and chemical parameters of an Apennine watercourse of central Italy: The river Tenna', Ecological Indicators, 10, 910–913.

Turak E., Flack Lloyd K., Norris Richard H., Simpson Justen and Waddell Natacha (1999). Assessment of river condition at a large spatial scale using predictive models. Freshwater Biology 41, 283-298.

UNECE (1994). "ECE standard statistical classification of surface freshwater quality for the maintenance of aquatic life".

Ute S., Enderlein Rainer, Enderlein E., and Williams W. Peter (1997). Water Quality Requirements. In Water Pollution Control - A Guide to the Use of Water Quality Management Principles Edited by Richard Helmer and Ivanildo Hespanhol Published on behalf of the United Nations Environment Programme, the Water Supply & Sanitation Collaborative Council and the World Health Organization by E. & F. Spon © 1997 WHO/UNEP ISBN 0 419 22910 8).

Venkateswarlu V. and Reddy M. P. (1985). Algae as Biomonitor in river ecology sym. Biomonitoring state Envir. , 183- 189.

Verdonschot P. F. M., Nijboer R. C., Wright J. F., Sutcliffe D. W. and Furse, M. T. (2000). Typology of macrofaunal assemblages applied to water and nature management: A Dutch approach. In J. F. Wright, D. W. Sutcliffe, & M. T. Furse (Eds.), An international conference on assessing the biological quality of fresh waters: RIVPACS and other techniques (241–262). Oxford: Freshwater Biological Association.

Vos P., Wepener V. and Cyrus D. P. (2002). Efficiency of the SASS4 rapid bioassessment protocol in determining river health: A case study on the Mhlathuze River, KwaZulu-Natal, South Africa. Water SA 28, (1), 13-22.

Vugteveen P., Leuven R., Huijbregts M., Lenders H. (2006). Redefinition and elaboration of river ecosystem health: perspective for river management. Hydrobiologia 565, 289-308.

Washington H. G. (1984). Diversity, biotic and similarity indices. A review with special relevance to aquatic ecosystems. Water Research, 18: 653–694.

Whitton B. A. and Kelly M. G. (1995). Use of algae and other plants for monitoring rivers. Austral Ecology 20, 45-56.

Whitton B. A., Rott E. and Friedrich G. (1991). Use of Algae for Monitoring Rivers, E. Rott, Publisher, Institut für Botanik, Universität Innsbruck, Innsbruck, Austria.

William D. P. and Feltmate B. W. (1992). Aquatic insects C.A.B. International, Wallingford Oxon, UK.

Wright J. F. (1995). Development and use of a system for predicting the macroinvertebrate fauna of flowing waters. Australian Journal of Ecology, 20, 181-197.

Wright J. F., Sutcliffe D. W., Furse M. T. (2000). Assessing the Biological Quality of Fresh Waters: RIVPACS and Other Techniques. Freshwater Biological Association, Ambleside, UK, p. 400.

WWF-India (2019). DRAFT Rāmgangā River Basin Management Plan, India, Uttarakhand and Uttar Pradesh, India.

Xia Jun, Yongyong Zhang, Changsen Zhao, Stuart E. Bunn (2014). Bioindicator Assessment Framework of River Ecosystem Health and the Detection of Factors Influencing the Health of the Huai River Basin, China. Journal of Hydrologic Engineering, 19, (8).

Yadav N. S., Kumar A., Sharma M. P. (2014). Ecological health assessment of Chambal river using water quality parameters. Journal of Integrated Science and Technology, 2(2), 52-56.

Yadav N. S., Sharma M. P., Kumar A. (2015). Ecological health assessment of Chambal river, India. Journal of Mater. Environ. Sci. 6(3), 613-618.

Yang, Y. H., Zhou, F., Guo, H. C., Sheng, H., Liu, H., Dao, X. & He, C. J. (2010) Analysis of spatial and temporal water pollution patterns in Lake Dianchi using multivariate statistical methods. Environmental Monitoring and Assessment 170(1), 407–416.

Ying Zhang, Ling Liu, Jianzhong Wang, Juan Chen and Chengpeng Lu (2009). An index of river health for river plain network regions. Ecohydrology of Surface and Groundwater Dependent Systems: Concepts, Methods and Recent Developments (Proc. of JS.1 at the Joint IAHS & IAH Convention, Hyderabad, India, September 2009). IAHS Publ. 328, 2009.

Żelazna-Wieczorek J. and Ziulkiewicz M. (2009). Using benthic diatoms in the assessment of spring water quality in suburban areas. Oceanological and Hydrobiological Studies International Journal of Oceanography and Hydrobiology XXXVIII, 121-131.

Zhang Y., Zhao R., Qu X. D. and Meng W. (2013). The researches of integrated river health assessment of Liaohe River basin. Engineering Science, 15, 11–18 [in Chinese with English abstract]

Zhang Z. S. and Huang X. F. (1991). Method for the Study of Freshwater Plankton, Beijing, China, Science Press.

Zhao Y. W. and Yang Z. F. (2005). River health: concept, assessment method and direction. Scientia Geographica Sinica 25(1), 119–124 (in Chinese).

Zhu H. and Chen J. (2000). Bacillariophyta of the Xizang Plateau, Beijing, Science Press.