Action plan workshop
for

Rejuvenation and Sustenance of Arkavathi River Basin

Saturday 25th July 2009

Organized by

Global Academy of Technology
and
Geological Society of India

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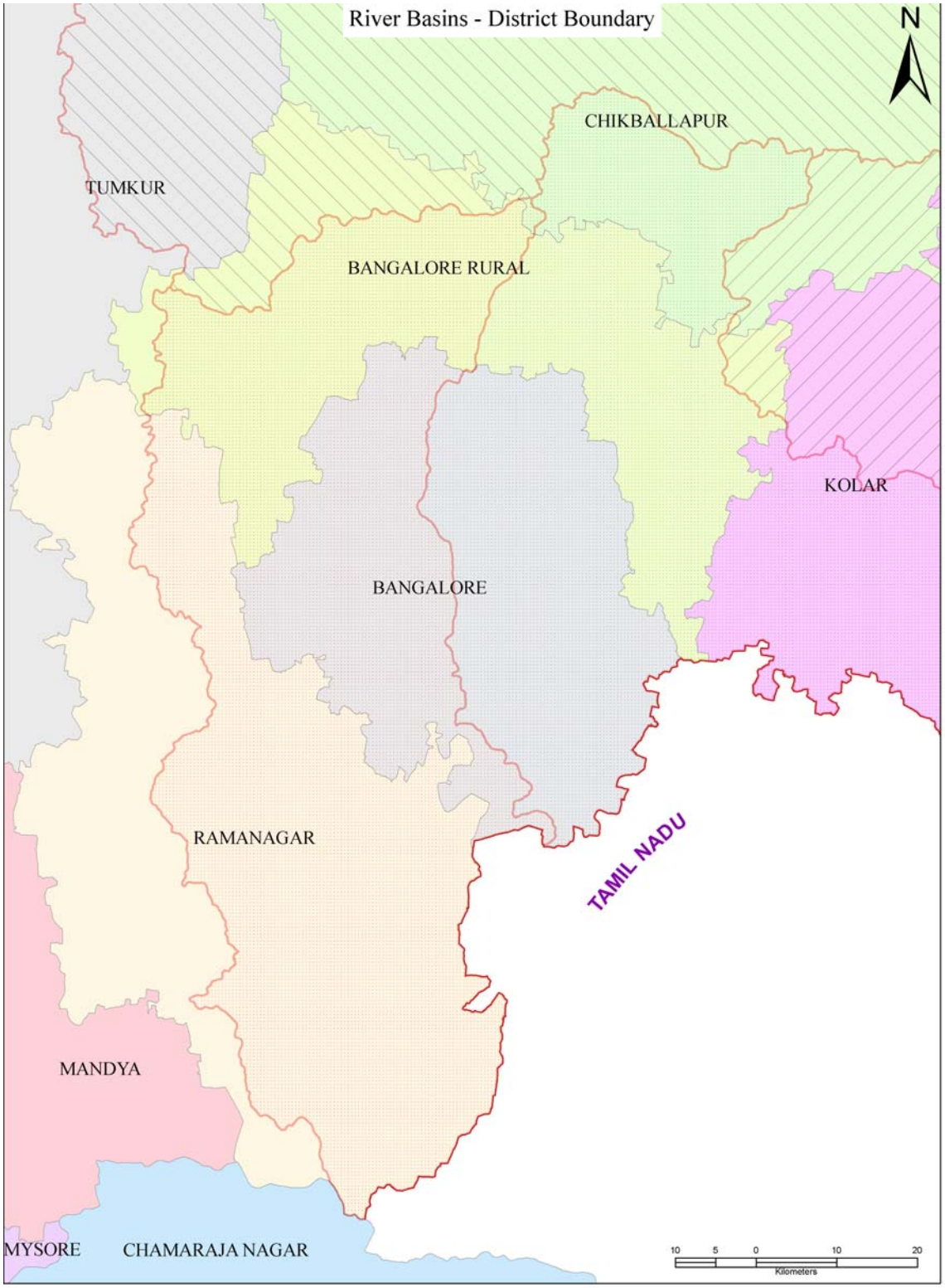
ಕಾರ್ಯಾಗಾರ - ಕುರಿತು

ಬೆಂಗಳೂರು ಮಹಾನಗರ ಬೆಳೆಯುತ್ತಲೇ ಇದೆ. ಜನಸಂಖ್ಯೆ ಹೆಚ್ಚಿದಂತೆಲ್ಲ, ಮೂಲ ಸೌಕರ್ಯಗಳ ಅಗತ್ಯವು ಹೆಚ್ಚಿ, ಹಲವಾರು ಅಭಿವೃದ್ಧಿ ಕಾರ್ಯಕ್ರಮಗಳು ಜಾರಿಯಲ್ಲಿವೆ. ಈ ಮೂಲ ಸೌಕರ್ಯ ಅಭಿವೃದ್ಧಿಯ ಪರಿಣಾಮ, ಎಲ್ಲಕ್ಕೂ ಮೂಲ ನೈಸರ್ಗಿಕ ಸಂಪನ್ಮೂಲವಾದ ಜಲ ಸಂಪನ್ಮೂಲದ ಅವನತಿಗೆ ಕಾರಣವಾಗುತ್ತಿರುವುದು ಆತಂಕಕಾರಿ ವಿಷಯ. ಪ್ರಸ್ತುತ ಪರಿಸ್ಥಿತಿಯಲ್ಲಿ ಅನೇಕ ವಿಚಾರ ಸಂಕೀರಣಗಳು, ಮಾಧ್ಯಮ ವರದಿಗಳು ಎಚ್ಚರಿಕೆಯ ಗಂಟೆಯನ್ನು ಬಾರಿಸುತ್ತಲಿವೆ. ಸ್ವರಾಜ್ ಎಂಬ ಸ್ವಯಂಸೇವ ಸಂಸ್ಥೆಯೊಂದು ನಾಲ್ಕೈದು ವರ್ಷಗಳ ಹಿಂದೆಯೇ, ನಂದಿ ಬೆಟ್ಟದಿಂದ ದೊಡ್ಡಬಳ್ಳಾಪುರದವರೆಗೆ ಪ್ರತಿಗ್ರಾಮಗಳಲ್ಲಿ ಅರ್ಕಾವತಿ ಪುನಶ್ಚೇತನ ಕಾರ್ಯದ ಬಗ್ಗೆ ಅರಿವುಂಟುಮಾಡಲಾರಂಬಿಸಿತು. ಈಗಲೂ ಸಹ ದೊಡ್ಡಬಳ್ಳಾಪುರದಲ್ಲಿ ಈ ಕೆಲಸಕ್ಕಾಗಿಯೇ ಒಂದು ಘಟಕವನ್ನು ಸ್ಥಾಪಿಸಿಕೊಂಡು ನಾಗರ ಕೆರೆ ಸ್ವಚ್ಚತೆ ಬಗ್ಗೆ ಕೆಲಸಮಾಡುತ್ತಲಿದೆ. ಈ ಸಂಸ್ಥೆಯೊಂದಿಗೆ ಭಾರತೀಯ ಭೂವೈಜ್ಞಾನಿಕ ಸಂಘ ಮತ್ತು ಅರ್ಕಾವತಿ ಕುಮುದ್ವತಿ ಟ್ರಸ್ಟ್ ಸೇರಿದಂತೆ ಇನ್ನು ಅನೇಕ ಸಂಘಸಂಸ್ಥೆಗಳು ಕೈಜೋಡಿಸಿವೆ. ಜನವರಿ 2005ರಲ್ಲಿ ಅರ್ಕಾವತಿ ಮೊದಲ ಕೆರೆ, ಚಿಕ್ಕರಾಯಪ್ಪನ ಕೆರೆಯ ಬಳಿ ಪರಿಸರ ತಜ್ಞ ಶ್ರೀ ಎಲ್ಲಪ್ಪರೆಡ್ಡಿಯವರಿಂದ ಒಂದು ಸಸಿನೆಡುವ ಕಾರ್ಯಕ್ರಮದಿಂದ ಪ್ರಾರಂಭವಾಯಿತು. ನಂತರ ನದಿ ಪುನಶ್ಚೇತನ ಕಾರ್ಯದಲ್ಲಿ ಹೆಸರುವಾಸಿಯಾದ ರಾಜಸ್ಥಾನದ ರಾಜೇಂದ್ರಸಿಂಗ್ ನೇತೃತ್ವದಲ್ಲಿ ಒಮ್ಮೆ ನಂದಿಬೆಟ್ಟದಿಂದ ಕಾವೇರಿಯವರೆಗೆ ಪಾದಯಾತ್ರೆಯನ್ನು ಸಹ ಕೈಗೊಳ್ಳಲಾಯಿತು. ಉತ್ತಮ ಮಳೆಯಾಗುತ್ತಿದ್ದರೂ ತಿಪ್ಪಗೊಂಡನಹಳ್ಳಿ ಜಲಾಶಯಕ್ಕೆ ಸಾಕಷ್ಟು ನೀರು ಹರಿದು ಬರದೆ ಇರುವುದಕ್ಕೆ ಕಾರಣ ಕಂಡುಹಿಡಿಯಲು ಬೆಂಗಳೂರು ಜಲಮಂಡಲಿಯು ಭಾರತೀಯ ಬಾಹ್ಯಾಕಾಶ ಸಂಶೋಧನ ಸಂಸ್ಥೆಯ ಸಹಯೋಗದೊಂದಿಗೆ ಅಧ್ಯಯನವನ್ನು ಕೈಗೊಂಡು ಆ ಅಧ್ಯಯನದ ಪ್ರಕಾರ ಕಾರ್ಯಾಚರಣೆ ಆಗದೆ ಇರುವ ವಿಚಾರವೂ ಸಹ ಚರ್ಚಿತವಾಗುತ್ತಿದೆ.

ಈ ಹಿನ್ನೆಲೆಯಲ್ಲಿ ಕಳೆದ ಫೆಬ್ರವರಿ ಅರರಂದು, ಶಾಸಕರ ಭವನದಲ್ಲಿ, ಅರ್ಕಾವತಿ ಪುನಶ್ಚೇತನದಲ್ಲಿ ಆಸಕ್ತಿ ಹೊಂದಿದ ಶಾಸಕರ ದುಂಡು ಮೇಜಿನ ಸಂವಾದ ನಡೆಯಿತು. ಈ ಸಂವಾದವನ್ನು ಸ್ವರಾಜ್ ಸಂಸ್ಥೆ ಸಂಯೋಜಿಸಿತ್ತು. ಈ ಸಭೆಗೆ ಹಲವಾರು, ಸ್ವಯಂಸೇವಾ ಸಂಘಗಳನ್ನು ವೈಜ್ಞಾನಿಕ ಸಂಸ್ಥೆಗಳನ್ನೂ ಆಹ್ವಾನಿಸಲಾಗಿತ್ತು. ಈ ಕಾರ್ಯಕ್ರಮದಲ್ಲಿ ಭಾಗವಹಿಸಿದ ಭಾರತೀಯ ಭೂವೈಜ್ಞಾನಿಕ ಸಂಘ ಮತ್ತು ಈ ಸಂಘದ ಕಾಪೋರೇಟ್ ಸದಸ್ಯ ಸಂಸ್ಥೆಯಾದ ಗ್ಲೋಬಲ್ ಅಕಾಡೆಮಿ ಆಫ್ ಟೆಕ್ನಾಲಜಿಯ ಸಂಶೋಧನಾ ಕೇಂದ್ರವೂ ಭಾಗವಹಿಸಿದ್ದು, ಈ ಎರಡೂ ಸಂಸ್ಥೆಗಳು ವಿಷಯದ ಪ್ರಾಮುಖ್ಯತೆ ಮತ್ತು ಸಾಮಾಜಿಕ ಕಳಕಳಿಯನ್ನರಿತು, ಸಮಸ್ಯೆ ಬಗೆಹರಿಸಲು ಬೇಕಾದ ಕ್ರಿಯಾಯೋಜನೆ (Action Plan)ಯನ್ನು ರಚಿಸುವ ಬಗ್ಗೆ ಒಂದು ಕಾರ್ಯಾಗಾರವನ್ನು ಹಮ್ಮಿಕೊಳ್ಳಲೂ ತೀರ್ಮಾನ ಕೈಗೊಂಡವು.

ಈ ಮಧ್ಯೆ ಗ್ಲೋಬಲ್ ಅಕಾಡೆಮಿ ಆಫ್ ಟೆಕ್ನಾಲಜಿಯ (ಈ ಕಾರ್ಯಗಾರದ ಸಂಯೋಜಕರು) ಸಿವಿಲ್ ಇಂಜಿನಿಯರಿಂಗ್ ವಿದ್ಯಾರ್ಥಿಗಳು ಅರ್ಕಾವತಿ ಜಲಾನಯನದ ದಕ್ಷಿಣ ಭಾಗದ ಗ್ರಾಮೀಣ ಪ್ರದೇಶದಲ್ಲಿರುವ ಒಂದು ಮೈಕ್ರೋ ವಾಟರ್ ಶೆಡ್‌ನ (ಕಿರುಜಲಾನಯನ) ಅಧ್ಯಯನ ಕೈಗೊಂಡು, ಅಲ್ಲಿಯ ಸಮಸ್ಯೆಗಳ ಬಗ್ಗೆ ಅರಿವುಂಟುಮಾಡುತ್ತಲಿದ್ದಾರೆ. ಈ ವಿಧ್ಯಾರ್ಥಿಗಳೊಂದಿಗೆ ದೊಡ್ಡ ಮುದವಾಡಿಯಲ್ಲಿಯೇ ಇರುವ **"ಸೇಕ್ರೆಡ್"** ಎಂಬ ಸ್ವಯಂಸೇವಾ ಟ್ರಸ್ಟ್, ಅಲ್ಲಿಯ ಸುತ್ತಮುತ್ತಲ ಹಳ್ಳಿಗಳಲ್ಲಿ ಕಂಪ್ಯೂಟರ್ (ಗಣಕಯಂತ್ರ) ಕಲಿಕೆ, ಇಂಗ್ಲೀಷ್ ಭಾಷಾ ಭೋದನೆ ಮತ್ತು ಪರಿಸರ ಸಮಸ್ಯೆಗಳ ಅರಿವು ಮೂಡಿಸಲು ಪ್ರತಿ ವರ್ಷ ವಿಭಿನ್ನ ಪ್ರದರ್ಶನ ಏರ್ಪಡಿಸುತ್ತ ಬಂದಿದ್ದು, ಈಗ ಅರ್ಕಾವತಿ ಜಲಾನಯನದ ಗ್ರಾಮೀಣ ಭಾಗದಲ್ಲಿ ಜಲಸಂರಕ್ಷಣೆ ಬಗ್ಗೆ ಅರಿವುಂಟುಮಾಡಲು ಮುಂದಾಗಿದೆ. ಇಂತಹ ವಿಚಾರಗಳು ಅರ್ಕಾವತಿ ನದಿ ಜಲಾನಯನ ಪ್ರದೇಶವನ್ನು ಪ್ರತಿನಿಧಿಸುವ ಎಲ್ಲಾ ಶಾಸಕರಿಗೆ ಮತ್ತು ಬೆಂಗಳೂರುನಗರ ಪ್ರದೇಶದಲ್ಲಿ ಕಾರ್ಯನಿರತವಾಗಿರುವ ನೀರಿನ ಬಳಕೆದಾರ ಸರ್ಕಾರಿ ಇಲಾಖೆಗಳ ಕಾರ್ಯಚಟುವಟಿಕೆಗಳಲ್ಲಿ ನದಿ ಪುನಶ್ಚೇತನಕ್ಕೆ ಅವಶ್ಯವಾದ ಕಾರ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳುವ ಬಗ್ಗೆ ಗಮನಹರಿಸಿ ಅರ್ಕಾವತಿ ನದಿ ಜಲಾನಯನದ ಪುನಶ್ಚೇತನ ಮತ್ತು ಸುಸ್ಥಿರತೆಗಾಗಿ ಕ್ರಿಯಾಸೂಚಿ ತಯಾರಿಕೆ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವ ಒಂದು ಕಾರ್ಯಗಾರ ಇದಾಗಬೇಕೆಂದು ಡಾ॥ ಎಲ್ಲಪ್ಪರೆಡ್ಡಿಯವರ ನೇತೃತ್ವದಲ್ಲಿ ತಜ್ಞರ ಸಮಿತಿಯನ್ನು ನೇಮಿಸಲಾಗಿದೆ.

ಪರಿಸರ ತಜ್ಞರಾದ ಡಾ॥ ಎ.ಎನ್. ಎಲ್ಲಪ್ಪ ರೆಡ್ಡಿಯವರ ಅಧ್ಯಕ್ಷತೆಯಲ್ಲಿ ವಿವಿಧ ವಿಷಯ ತಜ್ಞರ ಸಮಿತಿ ರಚಿಸಿಕೊಂಡು ಕಾರ್ಯಾಗಾರದ ರೂಪುರೇಶೆ ಮತ್ತು ಚರ್ಚಿಸಬೇಕಾದ ವಿಷಯಗಳ ಲೇಖನಗಳ ಹೊತ್ತಿಗೆಯನ್ನು ಹೊರತಂದು ಕಾರ್ಯಾಗಾರದಲ್ಲಿ ಚರ್ಚೆಗೆ ಇಡಲಾಗಿದೆ.


River Basins - District Boundary
N
CHIKBALLAPUR
TUMKUR
BANGALORE RURAL
KOLAR
BANGALORE
TAMIL NADU
RAMANAGAR
MANDYA
MYSORE
CHAMARAJA NAGAR
10 5 0 10 20
Kilometers

ಅರ್ಕಾವತಿ ದರ್ಶನ

ಡಾ॥ ವೈ. ಲಿಂಗರಾಜು
ಪ್ರಾಧ್ಯಾಪಕರು ಮತ್ತು ಸಂಶೋಧನಾ ಮಾರ್ಗದರ್ಶಕರು, ಗ್ಲೋಬಲ್ ಅಕಾಡೆಮಿ ಆಫ್ ಟೆಕ್ನಾಲಜಿ
ನಿವೃತ್ತ ನಿರ್ದೇಶಕರು, ಕರ್ನಾಟಕ ದೂರ ಸಂವೇದಿ ಕೇಂದ್ರ ಮತ್ತು ಜಿಯೋಮ್ಯಾಟಿಕ್ಸ್ ಕೇಂದ್ರ
ಜಲಸಂಪನ್ಮೂಲ ಅಭಿವೃದ್ಧಿ ಸಂಸ್ಥೆ, ಕರ್ನಾಟಕ ಸರ್ಕಾರ

ಅನೇಕ ಜಗತ್ ಪ್ರಸಿದ್ಧ ನಗರಗಳು ನದಿ ತಟಗಳಲ್ಲಿರುವಂತೆ ಬೆಂಗಳೂರು ಮಹಾ ನಗರವೂ ಸಹ ಅರ್ಕಾವತಿ ಮತ್ತು ದಕ್ಷಿಣ ಪಿನಾಕಿನಿ ನದಿ ತಟಗಳಲ್ಲಿ ಹರಡಿಕೊಳ್ಳುತ್ತಿದೆ. ನಗರದ ಬೆಳವಣಿಗೆಗೆ ಮೂಲ ಕಾರಣವಾದ ತಿಪ್ಪಗೊಂಡನಹಳ್ಳಿ ಮತ್ತು ಹೆಸರು ಘಟ್ಟ ಜಲಾಶಯಗಳು ಅರ್ಕಾವತಿ ಜಲಾನಯನದ ಹೃದಯ ಭಾಗಗಳೆನ್ನಬಹುದು. ಮಹಾನಗರದ ಹೆಚ್ಚಿನ ಬೆಳವಣಿಗೆ ಕಾವೇರಿ ಮಹಾನದಿಯ ಉಪನದಿಯಾದ ಅರ್ಕಾವತಿ ಜಲಾನಯನದಲ್ಲೇ ಆಗಿದ್ದು, ಈ ನಿಸರ್ಗದತ್ತ ಕೊಡುಗೆಯ ಪರಿಚಯ ಮಾಡಿಕೊಳ್ಳೋಣ. ನಗರದ ಸುತ್ತಲಿರುವ ಎತ್ತರ ಪ್ರದೇಶಗಳಾದ ಉತ್ತರದಲ್ಲಿ, ನಂದಿಬೆಟ್ಟ ಪೂರ್ವದಲ್ಲಿ, ಬನ್ನೇರುಘಟ್ಟ ಮತ್ತು ಪಶ್ಚಿಮದಲ್ಲಿ, ಶಿವಗಂಗೆ ಬೆಟ್ಟಗಳ ಕಡೆಯಿಂದ ದಕ್ಷಿಣಕ್ಕೆ ಧಾವಿಸುವ ನೂರಾರು ತೊರೆಗಳ ಜಾಲವೇ ಅರ್ಕಾವತಿ ಜಲಾನಯನ. ನಂದಿ ಬೆಟ್ಟದಲ್ಲಿ ಉಗಮಗೊಂಡು ಹೆಸರು ಘಟ್ಟ ಜಲಾಶಯದ ಮೂಲಕ ತಿಪ್ಪಗೊಂಡನಹಳ್ಳಿ ಜಲಾಶಯವನ್ನು ಸೇರಿ ಮುಂದೆ ರಾಮನಗರ ಮತ್ತು ಕನಕಪುರ ಮುಖೇನ ಸಂಗಮದ ಬಳಿ ಕಾವೇರಿಯನ್ನಪ್ಪುವ ಮುಖ್ಯ ತೊರೆಯೇ ಅರ್ಕಾವತಿ. ಈ ಮುಖ್ಯ ತೊರೆಗೆ ಶಿವಗಂಗೆ ಕಡೆಯಿಂದ ಹರಿದು ಬರುವ ಹಳ್ಳಗಳು ಸೇರಿ ತಿಪ್ಪಗೊಂಡನಹಳ್ಳಿ ಬಳಿ ಅರ್ಕಾವತಿ ಸೇರುವ ಭಾಗವೇ ಕುಮದ್ವತಿ ಕಿರು ನದಿ ಜಾಲ. ಪೂರ್ವದಲ್ಲಿ ಬನ್ನೇರುಘಟ್ಟ ಬೆಟ್ಟಗಳ ಸಾಲುಗಳೆಡೆ ಅನೇಕಲ್ಲು ಭಾಗದಿಂದ ಹರಿದು ಬಂದು ಬೆಂಗಳೂರು ದಕ್ಷಿಣ ಭಾಗದಲ್ಲಿ ಅರ್ಕಾವತಿಯನ್ನು ಸೇರುವ ತೊರೆಗಳ ಜಾಲವೇ ಸುವರ್ಣಮುಖಿ ಕಿರುನದಿ ಜಾಲ. ಹಾಗೆಯೇ ನಗರದ ಪೀಣ್ಯ ಭಾಗದಿಂದ ಪ್ರಾರಂಭವಾಗಿ ಜ್ಞಾನಭಾರತಿ ಮೂಲಕ ದಕ್ಷಿಣಕ್ಕೆ ಹರಿಯುತ್ತ ಕನಕಪುರದ ಉತ್ತರ ಭಾಗದಲ್ಲಿ ಅರ್ಕಾವತಿ ಸೇರುವ ಹೊನಲಿನ ಭಾಗವೇ ವೃಷಭಾವತಿ. ಹಾಗಾಗಿ ಅರ್ಕಾವತಿ ಉಪನದಿಗೆ ಕುಮುದ್ವತಿ, ಸುವರ್ಣಮುಖಿ ಹಾಗೂ ವೃಷಭಾವತಿ ಸಮಾಗಮಿಸಿ ಹರಿಯುತ್ತಾ ಕಾವೇರಿಯನ್ನು ಸಮಾಗಮಿಸುವ ಚಿತ್ರಣವನ್ನು ನಾವು ಕಾಣಬಹುದು (ನಕ್ಷೆ ನೋಡಿ). ಅರ್ಕಾವತಿ ಉಗಮಸ್ಥಾನವೆಂದು ಕರೆಯಲ್ಪಡುವ ನಂದಿ ಬೆಟ್ಟ ಸಮುದ್ರ ಮಟ್ಟಕ್ಕಿಂತ 1466 ಮೀ ಎತ್ತರದಲ್ಲಿದ್ದು ಶಿವಗಂಗೆ 1386 ಎತ್ತರದಲ್ಲಿಯೂ ಬನ್ನೇರುಘಟ್ಟ 996 ಎತ್ತರವಿದ್ದು ಒಟ್ಟು ನದಿ ಸಮುದಾಯ ಕಾವೇರಿಯನ್ನು ಸಂಗಮಿಸುವ ಸ್ಥಾನ 373 ಮೀ ಎತ್ತರಕ್ಕಿದೆ. 1466 ಎತ್ತರದಿಂದ 373 ಮೀ ಎತ್ತರಕ್ಕೆ ಇರುವ ಇಳಿಜಾರಿನ 4043 ಕಿ.ಮೀ. ವಿಸ್ತೀರ್ಣ ಹರಿದು ಬರುವ ಹಳ್ಳಗಳನ್ನು ಅಡ್ಡಗಟ್ಟಿ ಕೆರೆಗಳನ್ನು ನಿರ್ಮಿಸಿದ ಕೀರ್ತಿ ಹಿಂದೆ ಬಾಳಿದ ಪೂರ್ವಿಕರದಾಗಿರುತ್ತದೆ. ಒಟ್ಟು ಒಂದು ಸಾವಿರದ ಏಳುನೂರ ಎಪ್ಪತ್ತೈದು ಕೆರೆಗಳನ್ನು ಮಳೆಯಾದಾಗಲೆಲ್ಲ ಭರ್ತಿಮಾಡಿ ಹರಿದು ಬಂದು ಕಾವೇರಿಯನ್ನು ಸೇರುವ ಈ ನದಿ ವ್ಯವಸ್ಥೆ ಹತ್ತಾರು ದಶಕಗಳಿಂದ ಫಲವತ್ತಾದ ಭೂಮಿಯನ್ನು ತಣಿಸಿ ಬೆಂಗಳೂರು ವನಸಿರಿ ನಗರ ಗಾರ್ಡನ್ ಸಿಟಿ ಎಂಬ ಖ್ಯಾತಿಗೆ ಕಾರಣವಾಗಿದೆ. ಇನ್ನೂ ಮುಖ್ಯವಾಗಿ ಕೆರೆ ಮತ್ತು ತೊರೆಗಳು ನೆಲದಾಳಕ್ಕೆ ನೀರನ್ನು ಜಿನುಗಿಸುತ್ತಾ ಅಮೂಲ್ಯ ಅಂತರ್ಜಲ ಶೇಖರಣೆಗೆ ಕಾರಣವಾಗಿದೆ. ಉಪಗ್ರಹ ಆಧಾರಿತ ಮಾಹಿತಿ ಚಿತ್ರಗಳೂ ಅರ್ಕಾವತಿ ನದಿಯ ಹಲವು ಮುಖಗಳ ಚಿತ್ರಗಳ ಸೆರೆ ಹಿಡಿಯಲು ಸಹಕಾರಿಯಾಗಿವೆ. ಇಂತಹ ಕೆಲವು ನಕ್ಷೆಗಳನ್ನು ಪರಿಚಯ ಮಾಡಿಕೊಂಡರೆ ನಮಗೆ ಅರ್ಕಾವತಿಯ ಸಮಗ್ರ ದರ್ಶನ ಆಗುತ್ತದೆ.

ನರನಾಡಿಯಂತಿರುವ ತೊರೆ ಮತ್ತು ಕೆರೆಗಳ ಜಾಲ

ಮುಖ್ಯವಾಗಿ ಮೂರು ಬೆಟ್ಟ ಪ್ರದೇಶಗಳಿಂದ ಪ್ರಾರಂಭವಾಗುವ ತೊರೆಗಳಿಗೆ ಅಸಂಖ್ಯಾತ ಕಿರು ಹಳ್ಳಗಳು ಒಂದನ್ನೊಂದು ಸೇರುತ್ತಾ ಹೋಗುವುದನ್ನು ನಕ್ಷೆಯಲ್ಲಿ ಕಾಣಬಹುದು. ಪ್ರತಿ ಬಾರಿ ಮಳೆಯಾದಾಗ ನೆಲದ ಮೇಲೆ ಬಿದ್ದ ಹನಿಗಳನ್ನು ಕೂಡಿಸಿ ಹರಿಸುತ್ತಾ ಹರಿವಿನುದ್ದಕ್ಕೂ ಅಲ್ಲಲ್ಲೇ ನಿರ್ಮಿಸಿರುವ ಸಾವಿರಾರು ಕೆರೆಗಳಲ್ಲಿ ಸಂಗ್ರಹಿಸುವುದಷ್ಟೇ ಅಲ್ಲ ಮಣ್ಣನ್ನು ತೋಯಿಸಿ ನೆಲದಾಳಕ್ಕೂ ಜಿನುಗಿಸಿ ಅಂತರ್ಜಲದ ಒರತೆಗಳನ್ನು ಒದಗಿಸುವಲ್ಲಿ ಈ ತೊರೆ ಮತ್ತು ಕೆರೆಗಳು ಮುಖ್ಯ ಪಾತ್ರವಹಿಸುತ್ತವೆ. ಹಾಗಾಗಿ, ಇಡೀ ಜಲಾನಯನದ ಭಾಗ ಒಂದು ಜೈವಿಕ ಘಟಕ ಎಂದು ಕೊಂಡರೆ ತೊರೆಗಳು ಈ ಘಟಕದ ನರಮಂಡಲದಂತೆ ಮತ್ತು ಕೆರೆಗಳು ನಾಡಿಗಳಂತೆ ವರ್ತಿಸಿ ಜೀವಜಲವನ್ನು ಸಮಗ್ರ ಜೀವಜಾಲಕ್ಕೆ ಸದಾ ಒದಗಿಸುವ ನೈಸರ್ಗಿಕ ವ್ಯವಸ್ಥೆ ಎಂಬುದನ್ನು ನಾವು ಮನಗಾಣಬಹುದು. ನಕ್ಷೆಯಲ್ಲಿ ಕಾಣುವಂತೆ ವಿವಿಧ ಬಣ್ಣದ ಹಳ್ಳಗಳ ಸಂಖ್ಯೆ ಇಡೀ ಜಲಾನಯದಲ್ಲಿ ಒಟ್ಟು 12508 ಇದ್ದು, ಇದರ ಉದ್ದ 8561 ಕಿ.ಮಿ. ಆಗುತ್ತದೆ. ಈ ತೊರೆಗಳಿಗೆ ಅಡ್ಡಲಾಗಿ ಕಟ್ಟಿರುವ ಕೆರೆಕಟ್ಟೆಗಳು ಒಟ್ಟು 1775 ಆಗಿರುತ್ತದೆ.

ಆಪತ್ತಿಗಾಗುವ ಅಂತರ್ಜಲಾಗರಗಳನ್ನು ಸೂಚಿಸುವ ಜಲ ಭೂವೈಜ್ಞಾನಿಕ ಚಿತ್ರಣ

ಕೋಟ್ಯಂತರ ವರ್ಷಗಳಿಂದ ರೂಪುಗೊಂಡ ಈ ನೆಲ ಭಾಗ, ನೈಸರ್ಗಿಕ ಜಲ ಚಕ್ರ ಪ್ರಕ್ರಿಯೆ ಎಂದರೆ ಮಳೆ ಬಿಸಿಲಿನಿಂದಾಗುವ ಋತುಮಾನಗಳ ಬದಲಾವಣೆಯಿಂದಾಗಿ ನೆಲದ ಮೇಲಿನ ಮಣ್ಣು ಅದರಡಿ ಇರುವ ಮೆದು ಮತ್ತು ಕಠಿಣ ಶಿಲೆಯಲ್ಲಿ ಹರಿದಾಡುತ್ತ ಬಂದ ಜಲ, ಅಂತರ್ಜಲಾಗರಗಳನ್ನು ಸೃಷ್ಟಿ ಮಾಡುತ್ತಲೇ ಬಂದಿದೆ. ಅಂತಹ ಅಂತರ್ಜಲಾಗರಗಳನ್ನು ಮತ್ತು ಅವು ಸಂಗ್ರಹಿಸಬಹುದಾದ ಸಾಮರ್ಥ್ಯವನ್ನು ಭೂ ಬಾಹ್ಯಸ್ವರೂಪ ದರ್ಶಕ (Geomorphology) ನಕ್ಷೆ ಸೂಚಿಸುತ್ತದೆ. ಈ ನಕ್ಷೆಯಲ್ಲಿ ಕಾಣುವಂತೆ ಉತ್ತಮ ಜಲಾಗರಗಳಾಗಬಲ್ಲ ಮತ್ತು ಸಾಧಾರಣ ಜಲಾಗರಗಳಾಗಬಲ್ಲ ಪ್ರದೇಶಗಳಿವೆ. ಇದನ್ನರಿತು ಮಳೆ ನೀರು ಸಂಗ್ರಹ ಮತ್ತು ವನಗಳ ವಿಸ್ತಾರ ಮಾಡಿದರೆ ಈ ಜಲಾಗರಗಳು ನೀರನ್ನು ಸಂಗ್ರಹಿಸಿ ಆಪತ್ಕಾಲದಲ್ಲಿ ಸಂರಕ್ಷಿಸುವ ಸೂಕ್ತ ವ್ಯವಸ್ಥೆಗಳಾಗುತ್ತವೆ.

ಜಲಾನಯನ ವಿಂಗಡಣೆ

ಇಡಿ ಜಲಾನಯನ ವ್ಯವಸ್ಥೆ ನೂರಾರು ಅತಿ ಕಿರಿದಾದ ಹಳ್ಳಗಳ ಸಮೂಹಗಳ ಸಮಾಗಮದಿಂದ ಆಗಿದ್ದು ಒಟ್ಟು 900 ಅತಿ ಕಿರಿದಾದ ಜಲಾನಯನಗಳನ್ನು ವಿಂಗಡಿಸಿ ಕೊಳ್ಳಬಹುದಾಗಿದೆ. ಮಳೆಹನಿ ಬಿದ್ದ ಆಸುಪಾಸಿನಲ್ಲೇ ಸಂಗ್ರಹಿಸಬಹುದಾದ ವ್ಯವಸ್ಥೆಯನ್ನು ಕಿರು ಜಲಾನಯನದ ಮಟ್ಟದಲ್ಲಿ ಅಲ್ಲಿ ವಾಸಿಸುವ ಜನತೆ ಅರ್ಥಮಾಡಿಕೊಂಡು ಸಂಗ್ರಹ ಕಾರ್ಯ ಮಾಡಿಕೊಂಡರೆ ಇಡಿ ಅರ್ಕಾವತಿ ಜೀವಂತಿಕೆ ಪಡೆದು ಕ್ರಮೇಣ ಪುನಃ ಜೀವಂತ ನದಿಯಾಗಿ ಹರಿಯಲು ಸಾಧ್ಯ. ಪ್ರತಿ ಕಿರುಜಲಾನಯನದಲ್ಲಿ ನೀರಿನ ಉಳಿಕೆ ಮತ್ತು ಬಳಕೆ ಸಮತೋಲನದಲ್ಲಿರಿಸಲು ಬೇಕಾದಂತಹ ಜಲಾನಯನ ಸಂರಕ್ಷಣಾ ಕ್ರಮಗಳನ್ನು ಕೈಗೊಂಡರೆ ಜಲ ಸಂಪನ್ಮೂಲದ ಸುಸ್ಥಿರತೆ ಸಾಧ್ಯ.

ನೆಲಬಳಕೆ

ವಿವಿದೋದ್ದೇಶಗಳಿಗೆ ಜಲಾನಯನ ಭಾಗಗಳನ್ನು ಬಳಸುವಾಗ ಆಗುವ ವೈಪರೀತ್ಯಗಳು ಆಯಾ ಭಾಗದಲ್ಲಿ ಸಂಚಲಿಸುವ ಜಲಚಕ್ರದ ಆಯ ತಪ್ಪಿಸಿ ಜಲಕ್ಷೋಭೆ ಅಥವಾ ಮಲಿನತೆಗೆ ಕಾರಣವಾಗುತ್ತದೆ. ಅದಕ್ಕಾಗಿ ನೆಲ ಮತ್ತು ಜಲ ಸಂರಕ್ಷಣೆಯನ್ನು ಆದ್ಯತೆ ಇಟ್ಟುಕೊಂಡು ನೆಲ ಬಳಕೆಯ ಯೋಜನೆಗಳನ್ನು ಕೈಗೊಂಡರೆ ಆಗುವ ಅನಾಹುತಗಳನ್ನು ತಪ್ಪಿಸಬಹುದು.

ಲೇಖನಗಳ ಸಾರಾಂಶ

ಅರ್ಕಾವತಿ ನದಿ ಪುನಶ್ಚೇತನ ಕುರಿತ ಹದಿನಾಲ್ಕು ಲೇಖನಗಳನ್ನು ಈ ಹೊತ್ತಿಗೆಯಲ್ಲಿ ಪ್ರಕಟಿಸಲಾಗಿದೆ. ಕಾರ್ಯಾಗಾರದ ಸಮಯದಲ್ಲಿ ಚರ್ಚೆಗೆ ಸಹಕಾರಿಯಾಗಲು ಲೇಖನಗಳ ಸಾರಾಂಶವನ್ನು ಈ ಲೇಖನದಲ್ಲಿ ನೀಡಲಾಗಿದೆ.

ಅರ್ಕಾವತಿ ದರ್ಶನ ಎಂಬ ಲೇಖನದಲ್ಲಿ ಅರ್ಕಾವತಿ ನದಿ ಮತ್ತು ಜಲಾನಯನದ ರೂಪು ರೇಶೆಯನ್ನು, ಜಲಾನಯನದ ಭೌಗೋಳಿಕ ವಿಸ್ತೀರ್ಣ, ಜಲ ಭೂವೈಜ್ಞಾನಿಕ ಅಂಶಗಳನ್ನು ಪರಿಚಯಿಸಲಾಗಿದೆ. ಈ ಲೇಖನದ ಸಾರಾಂಶ ಮಳೆ ನೀರು, ನೆಲದ ಮೇಲಿನ ನೀರು ಮತ್ತು ಅಂತರ್ಜಲ ಶೇಖರಣೆ ಪ್ರಕ್ರಿಯೆಗಳಿಗೆ ಇರುವ ಸಾವಯವ ಸಂಬಂಧ ಮತ್ತು ಸ್ವಾಭಾವಿಕವಾಗಿ ಜಲಸಂರಕ್ಷಣೆಗೆ ಇರುವ ವ್ಯವಸ್ಥೆ ಮತ್ತು ಮಾನವ ನಿರ್ಮಿತ ಕೆರೆಗಳ ಪಾತ್ರವನ್ನು ಉಪಗ್ರಹ ಮಾಹಿತಿ ಆಧಾರಿತ ನಕ್ಷೆಗಳು ನೈಜ ಚಿತ್ರಣ ನೀಡುತ್ತವೆ. ಈ ರೀತಿಯ ಚಿತ್ರಣವನ್ನು ಇತ್ತೀಚಿನ ಮಾಹಿತಿ ಚಿತ್ರಗಳ ಮುಖೇನ ಆಯಾ ಪ್ರದೇಶದಲ್ಲಿ ಆಗಿಂದಾಗ್ಗೆ ಆಗುವ ಬದಲಾವಣೆಗಳ ಸಹಿತ ಇನ್ನೂ ಹೆಚ್ಚಿನ ವಿವರಣೆಗಳೊಂದಿಗೆ ಪಡೆಯಬಹುದಾಗಿರುತ್ತದೆ.

ಡಾ॥ ಸಿ.ವಿ.ಶ್ರೀನಿವಾಸರವರು ತಮ್ಮ ಅಧ್ಯಾಪನ ಮತ್ತು ಸಂಶೋಧನ ಅನುಭವ ದ ಹಿನ್ನೆಲೆಯಲ್ಲಿ ನಗರೀಕೃತ ವಲಯಗಳಲ್ಲಿ ನೀರಿನ ಪ್ರಾಪ್ತ ಉಪಯೋಗಕ್ಕಿಂತ ಮಲಿನ ಗೊಳಿಸುವ ಪ್ರಮಾಣವೇ ಹೆಚ್ಚಾಗಿದ್ದು, ಶುದ್ಧ ಜಲ ಲಭ್ಯತೆಗೆಗ ಧಕ್ಕೆಯಾಗುತ್ತಿರುವ ವಿಚಾರವನ್ನು ವಿಶ್ವದಾದ್ಯಂತ ಅನೇಕ ಸಂಶೋಧಕರು ಬೆಸ್ಟ್ ಮೆತೆಡ್ ಆಫ್ ಪ್ರಾಕ್ಟೀಸಸ್ (CBMP) ಎಂದರೆ ಅತ್ಯುತ್ತಮ ಬಳಕೆ ವಿಧಾನಗಳನ್ನು ಕಂಡುಕೊಂಡಿರುವುದು ಆ ವಿಧಾನಗಳನ್ನು ಜಾರಿಗೊಳಿಸಲು ಬೇಕಾದ ನಿಯಮಗಳನ್ನು ಚರ್ಚಿಸುತ್ತಾ, ಅರ್ಕಾವತಿ ಜಲಾನಯನ ಅಂತಹ ಸಮಸ್ಯೆಯಿಂದ ಹೊರಬರಲು ಅಳವಡಿಸಬೇಕಾಗಬಹುದಾದ ವಿಧಾನಗಳನ್ನು ಅವರ ಲೇಖನದಲ್ಲಿ ವಿವರಿಸಿದ್ದಾರೆ.

ಜಲಸಂಪನ್ಮೂಲ ವಿಷಯಗಳಲ್ಲಿ ಅಪಾರ ಅನುಭವವುಳ್ಳ , ನೀರಾವರಿ ವಿಷಯದಲ್ಲಿ ಸರ್ಕಾರದ ಕಾರ್ಯದರ್ಶಿಯಾಗಿ ನಿವೃತ್ತರಾಗಿರುವ **ಕ್ಯಾಪ್ಟನ್ ಎಸ್. ರಾಜಾರಾವ್** ರವರು, ಬೆಂಗಳೂರು ನಾಗರೀಕರಿಗಿರುವ ನೀರಿನ ಬೇಡಿಕೆ, ಕಾವೇರಿ ನದಿಯಿಂದ ಪಡೆಯಬಹುದಾದ ಪ್ರಮೇಯ ಮುಂದೆ ಉಂಟಾಗಬಹುದಾದ ಭೀಕರ ಪರಿಣಾಮ ಕುರಿತು ದೀರ್ಘವಾಗಿ ವಿಶ್ಲೇಷಣೆ ಮಾಡಿ ಎಚ್ಚರಿಕೆ ನೀಡುವುದರೊಂದಿಗೆ ಅನೇಕ ಸಲಹೆಗಳನ್ನು ನೀಡಿದ್ದಾರೆ.

ಸರ್ಕಾರದಲ್ಲಿ ದಕ್ಷ ಆಧಿಕಾರಿಯಾಗಿ ವಿವಿಧ ಇಲಾಖೆಗಳಲ್ಲಿ ಕೆಲಸ ಮಾಡಿ ಅಪರ ಮುಖ್ಯ ಕಾರ್ಯದರ್ಶಿಯಾಗಿ ನಿವೃತ್ತರಾದ, ಸ್ಪಷ್ಟ ಮತ್ತು ನೇರ ನುಡಿಗಳ **ಶ್ರೀ ವಿ.ಬಾಲಸುಬ್ರಮಣಿಯನ್** ರವರು, ಬೆಂಗಳೂರು ನಗರದ ಸಾವಿರಾರು ಕೆರೆಗಳ ಹದಗೆಟ್ಟ ಪರಿಸ್ಥಿತಿ, ಅದಕ್ಕೆ ಕಾರಣಗಳನ್ನು ನಿಷ್ಠೂರವಾಗಿ ವಿಶ್ಲೇಷಿಸುತ್ತಾ ಅವುಗಳನ್ನು ಉಳಿಸುವ ಕಾರ್ಯದ ಅವಶ್ಯಕತೆ ಮತ್ತು ವಿಧಾನಗಳನ್ನು ನೀಡಿದ್ದಾರೆ.

ಬೆಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯದ ಪರಿಸರ ವಿಜ್ಞಾನದ ಪ್ರಾಧ್ಯಾಪಕಿ ಡಾ॥ **ಕೆ.ನಂದಿನಿ**ರವರು ಪ್ರಖ್ಯಾತ ಪರಿಸರ ತಜ್ಞ **ಡಾ॥ ಎ.ಎನ್.ಎಲ್ಲಪ್ಪರೆಡ್ಡಿ**ಯವರ ಜೊತೆಗೆ ಬರೆದಿರುವ ಲೇಖನದಲ್ಲಿ ಅರ್ಕಾವತಿ ಜಲಾನಯನದ ಪರಿಸರ ಹಾಳಾಗಲು ಕಾರಣವಾದ ಕೊಳಚೆ ನೀರು, ಪರಿಸರ ಸಮತೋಲನ ಕಾಪಾಡಲು ಕಾರಣವಾಗುವ ತೇವ ನೆಲಗಳ ಕಬಳಿಕೆ, ಕಲ್ಲುಗಣಿಗಾರಿಕೆ, ನದಿಯ ಒಡಲು ಬಗೆದು ಮರಳಿನ ಕಳ್ಳಸಾಗಾಣೆ, ಅರಣ್ಯ ನಾಶ, ವಿಚಾರಗಳ ಬಗ್ಗೆ ಅಧ್ಯಯನ ಮಾಡಿ ವಿವರಿಸಿದ್ದಾರೆ. ಅಲ್ಲದೆ ಜಲ ಮತ್ತು ಪರಿಸರ ಸಂರಕ್ಷಣೆ ಇರುವ ಹಕ್ಕಿನ ಬಗ್ಗೆ ಪ್ರತಿಪಾದನೆ ಮಾಡಿದ್ದಾರೆ. ಅನೇಕ ಸ್ಥಳೀಯ ಅಧ್ಯಯನಗಳನ್ನು ನಡೆಸಿ ವಿವರಣೆ ನೀಡಿದ್ದಾರೆ.

ಗಣಿ ಮತ್ತು ಭೂ ವಿಜ್ಞಾನ ಇಲಾಖೆಯ ನಿವೃತ್ತ ಅಪರ ನಿರ್ದೇಶಕರಾದ **ಡಾ॥ ಟಿ.ಎನ್. ವೇಣುಗೋಪಾಲ್** ಮತ್ತು ಕೇಂದ್ರಿಯ ಅಂತರ್ಜಲ ಮಂಡಳಿ ಸದಸ್ಯರಾಗಿ **ಶ್ರೀ ಸಿ.ಎಸ್. ರಾಮಶೇಷ**ರವರು ಅರ್ಕಾವತಿ ಜಲಾನಯನದ ಕಿರು ಜಲಾನಯನವಾರು ಅಂತರ್ಜಲ ಲಭ್ಯತೆ ಮತ್ತು ಬಳಕೆ ಬಗ್ಗೆ ಕೈಗೊಂಡ ಅಧ್ಯಯನದ ಫಲಿತಾಂಶವನ್ನು ವಿವರಿಸುತ್ತ ಅಂತರ್ಜಲದ ಅತಿಯಾದ ಬಳಕೆಯಿಂದ ಅಂತರ್ಜಲಾಶಯಗಳು ಬರಿದಾಗುತ್ತಿದ್ದು, ಮಳೆ ನೀರು ಸಂಗ್ರಹಣೆ ಮತ್ತು ಅಂತರ್ಜಲ ಪುನರ್ ಭರಣೆಯ ಅಗತ್ಯತೆಯನ್ನು ಒತ್ತಿ ಹೇಳಿದ್ದಾರೆ.

ಶ್ರೀ ಆರ್. ಮಂಜುನಾಥ್, ಟೈಮ್ಸ್ ಸಮೂಹದ ಪತ್ರಕರ್ತ, ಇತ್ತೀಚೆಗೆ ವಿಜಯ ಕರ್ನಾಟಕದಲ್ಲಿ ಅರ್ಕಾವತಿ ಏಕೀ ದುರ್ಗತಿ ಎಂಬ ಸಚಿತ್ರ ಸರಣಿ ಲೇಖನ ಪ್ರಕಟಿಸಿದ್ದು ಅವರ ಅನಿಸಿಕೆಯನ್ನು ಬರೆದಿದ್ದಾರೆ.

ಭೌಗೋಳಿಕ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನದ ತಜ್ಞರಾದ **ಡಾ॥ ವಿ.ಆರ್.ಹೆಗ್ಡೆ** ಅರ್ಕಾವತಿ ಜಲಾನಯನದ ನೈಸರ್ಗಿಕ ವ್ಯವಸ್ಥೆ ಮತ್ತು ಅಭಿವೃದ್ಧಿ ಕಾರ್ಯಚಟುವಟಿಕೆಗಳನ್ನು ಚಿತ್ರ ಮತ್ತು ಮಾಹಿತಿ ಸಹಿತ ನೇರವಾಗಿ ಶಾಸಕರು ಮತ್ತು ನಾಗರೀಕರು ಸಕಾಲದಲ್ಲಿ ವೀಕ್ಷಿಸಿ

ಸಂರಕ್ಷಣೆಯಲ್ಲಿ ಭಾಗವಹಿಸಲು ತಂತ್ರಜ್ಞಾನದ ಲಭ್ಯ ಅನೂಕೂಲತೆಯನ್ನು ವಿವರಿಸುತ್ತ ಅಂತಹ ಔಪಯೋಗಿಕ ತಂತ್ರಜ್ಞಾನವನ್ನು ನದಿ ಸಂರಕ್ಷಣೆಗೆ ಬಳಸಿಕೊಳ್ಳುವ ಸಾಧ್ಯತೆಯನ್ನು ವಿವರಿಸಿದ್ದಾರೆ.

ಎನ್ವಿರಾನ್‌ಮೆಂಟ್ ಪ್ರೊಟೆಕ್‌ಶನ್ ಇನ್ಸ್‌ಟಿಟ್ಯೂಟಿನ ಅಧ್ಯಕ್ಷರಾದ **ಪ್ರೊ. ಶಿವಶಂಕರ್**, ತಮ್ಮ ಸುದೀರ್ಘ ಅಧ್ಯಯನಾನುಭವದ ಹಿನ್ನೆಲೆಯಲ್ಲಿ ಪರಿಸರ ಸಂರಕ್ಷಣೆಗೆ ಕಾನೂನಿನ ಅವಶ್ಯಕತೆಯನ್ನು ಸೂಚಿಸಿರುತ್ತಾರೆ.

ಮಳೆ ನೀರು ಸಂಗ್ರಹಣೆ, ಸ್ವಾಭಾವಿಕ ಜಲ ಸಂಪನ್ಮೂಲಗಳ ಸಂರಕ್ಷಣೆ, ಬಳಕೆದಾರರ ಭಾಗವಹಿಸುವಿಕೆ ಮುಂತಾದ ವಿಚಾರವಾಗಿ ತೀವ್ರ ಕಾಳಜಿ ವಹಿಸುತ್ತಿರುವ **ಶ್ರೀ ಎಸ್.ವಿಶ್ವನಾಥ್**ರವರು, ಅರ್ಘ್ಯಂ ಸಂಸ್ಥೆಯ ಸಲಹೆಗಾರರಾಗಿದ್ದು, ಅವರ ಲೇಖನದಲ್ಲಿ ಕರ್ನಾಟಕ ರಾಜ್ಯ ತನ್ನ ಜಲನೀತಿಯಲ್ಲಿ ತಿಳಿಸಿರುವಂತೆ ಹಾಗೂ ಈಗಾಗಲೇ ಬಳಕೆದಾರರ ಭಾಗವಹಿಸುವಿಕೆಯನ್ನು ಅನೇಕ ಕಾರ್ಯಕ್ರಮಗಳಲ್ಲಿ ರೂಢಿಸಿಕೊಂಡಿರುವಂತೆ ಅರ್ಕಾವತಿ ಪುನಶ್ಚೇತನ ಕಾರ್ಯಕ್ರಮಕ್ಕೂ ಅಳವಡಿಸಲು ಅನುವಾಗುವಂತೆ ಅರ್ಕಾವತಿ ಜಲಾನಯನ ನಿರ್ವಹಣೆ ಸಂಸ್ಥೆಯ ಅಗತ್ಯತೆಯನ್ನು ಸೂಚಿಸಿದ್ದಾರೆ.

ಸೇಕ್ರೆಡ್ ಸ್ವಯಂ ಸೇವಾ ಸಂಸ್ಥೆಯ ಅಧ್ಯಕ್ಷರಾದ **ಡಾ|| ವಿ.ಎನ್. ವಾಸುದೇವ್**ರವರು ದೊಡ್ಡಮುದವಾಡಿ ಕಿರು ಜಲಾನಯನ ಪ್ರದೇಶದ ಗ್ರಾಮಗಳ ಸದಸ್ಯರು ಮತ್ತು ಶಾಲಾ ಮಕ್ಕಳು ಹಾಗೂ ಗ್ಲೋಬಲ್ ಅಕಾಡೆಮಿ ಆಫ್ ಟೆಕ್ನಾಲಜಿ ಕಾಲೇಜಿನ ವಿದ್ಯಾರ್ಥಿಗಳ ಸಹಯೋಗದೊಂದಿಗೆ ಕೈಗೊಂಡ ಅಧ್ಯಯನ ಮತ್ತು ಮುಂದೆ ಕೈಗೊಳ್ಳಬಹುದಾದ ಕಾರ್ಯಕ್ರಮಗಳ ರೂಪುರೇಶೆಗಳನ್ನು ವಿವರಿಸಿದ್ದಾರೆ. ಈ ತೆರನಾದ ಜನಗಳ ಭಾಗವಹಿಸುವಿಕೆ ಒಟ್ಟಾರೆ ನದಿ ವ್ಯವಸ್ಥೆಯ ಸಂರಕ್ಷಣೆಗೆ ಸಹಕಾರಿಯಾಗಿರುತ್ತದೆ.

ಗಣಿ ಮತ್ತು ಭೂ ವಿಜ್ಞಾನ ಇಲಾಖೆಯ ಮುಖ್ಯ ರಸಾಯನಿಕ ತಜ್ಞೆ **ಶ್ರೀಮತಿ ಶಶಿರೇಖ**ರವರು ಬೆಂಗಳೂರು ಮತ್ತು ರಾಮನಗರ ಜಿಲ್ಲೆಗಳಲ್ಲಿ ಸಂಗ್ರಹಿಸಿದ ನೀರಿನ ಮಾದರಿಗಳನ್ನು ವಿಶ್ಲೇಶಿಸಿ ಮೇಲ್ಮೈ ಮತ್ತು ಅಂತರ್ಜಲ ಕಲುಷಿತಗೊಂಡಿರುವ ವಿಚಾರಗಳನ್ನು ಹೊರಗೆಡಹಿದ್ದಾರೆ. ಇಂತಹ ಆತಂಕಕಾರಿ ಪರಿಣಾಮಗಳಿಗೆ ಕಾರಣಗಳನ್ನು ಅವರ ಲೇಖನದಲ್ಲಿ ಸೂಚಿಸಿದ್ದಾರೆ.

ಬೆಂಗಳೂರು ಮಹಾನಗರ ಪಾಲಿಕೆಯ ಮುಖ್ಯ ಇಂಜಿನಿಯರ್ **ಸತೀಶ್**ರವರು ಪಾಲಿಕೆಯ ವತಿಯಿಂದ ಕೈಗೊಂಡಿರುವ ಕಾರ್ಯಕ್ರಮಗಳ ವಿವರಣೆ ನೀಡಿದ್ದಾರೆ.

URBAN HYDROLOGY – EMERGING PERSPECTIVE

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Hydrology and Urban Hydrology:

Hydrology treats waters of the earth, their occurrence, circulation, and distribution, their chemical & physical properties, and their reaction with their environment, including their relation to living things.

Interaction of urban environment with physical and chemical hydrology at the intersection of several traditional fields like hydro-climatology, stream hydrology, ground-water hydrology, limnology, contaminant hydrology, and water resources planning & policy defines the realm of *Urban Hydrology*.

The hydrological processes in urban areas are similar to those in rural areas, but, they occur at much smaller temporal and spatial scales in urban areas than in rural regions. Their relative importance may be quite different (e.g., Infiltration). This has significant implications concerning data acquisitions; in particular data collected by a national network are rarely dense enough for urban drainage applications. They must be collected locally and for a sufficient amount of time.

Water availability (quantity and quality) is a very critical issue which will decide existence of our cities in future, because

- In urban areas water is used as a means of transport - runoff with all collected pollutants and transport of wastes.
- Any substance used in society will be present in waste water. Water can be treated to any degree of purity at an ever increasing cost. No matter how well treated there is always a detectable residue.
- Some substances are suitable for removal at treatment plants (e.g., organic matter, nutrient, bacteria) others are not suitable and should be removed at the source.
- Waste water treatment transfers pollution from one medium to another, i.e., solids and air.
- Environmental problems are treated in isolation - they have to be looked at in total.

Urban water use does not consume significant quantity of water but pollutes it, the withdrawal and return to the environment may limit applicability but not the availability, and the problem can be partially rectified by treatment and reuse. With special focus to

water contamination related to direct and indirect urban-pollution sources which pose serious challenge to urban water quality managers, following issues assume great significance.

- Occurrence of organic contaminants in streams and lakes transported by atmospheric or catchment-scale processes.
- Transition between surface water contaminant hydrology and ground water contaminant hydrology.
- Contaminant transport in ground water systems at catchment scale.
- Quantification of risk of surface and ground water pollution from anthropogenic activities.

ARKAVATHI Valley:

ARKAVATHI River is being polluted by accumulated waste water discharges from Bangalore thus rendering the river water unfit for use even during monsoon. All water bodies connected to the river are also polluted resulting in contamination of ground water in all aquifers. Since major portion of the surface water and entire ground water regime is polluted the demand for clean and safe water for variety of needs is not being met. The preparation of action plan for urban centers, with the consent of citizens, farmers, elected representatives, nongovernmental organizations etc. through a single point of contact (SPOC) Governing Body has the potential to arrive at acceptable legislation for total compliance by all user groups in respect of waste disposal and management of all water sources and control of anthropogenic activities through Best Management Practices (BMP). This paves way for arriving at policy decisions and implementation solutions for

- Surface and subsurface water storage and distribution
- Waste water collection and treatment
- for environmentally benign land use

The Approach - an Example:

The changes which have started happening in many Urban Centers of USA through their *Nationwide Urban Runoff Program (NURP), Environmental Protection Agency (EPA), Combined Sewer Overflow (CSO)* identifies following changes in drainage design philosophy.

1. Introduction of the sustainable development concept.
2. The acceptance of the eco system approach to water resources management.
3. The improved understanding of drainage impacts on receiving waters.
4. The acceptance of the need to consider the components of the urban drainage

and waste water systems (drainage, sewage treatment plants and receiving waters) in an integrated manner.

Objectives of urban drainage:

In the context of infringing developments in urban drainage following objectives become very important for the water managers to fulfill the demand for safe water at affordable cost for variety of needs.

- Protection and Maintenance of safety and health of communities (removal of flood water and human waste).
- Protection of the natural environment (pollution control of streams and atmosphere).
- Sustainability of the system (long term and wide spread consequences).

Sustainability:

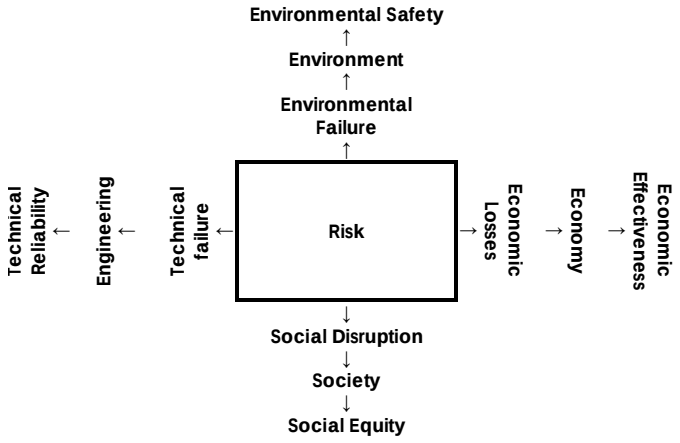
Sustainability may be defined in many of the following ways:

I. ASCE & UNESCO - Sustainable water systems are designed and managed to fully contribute to the objective of the society, now and in the future, while maintaining their ecological, environmental and hydrological integrity. This indicates continuity or prolonged or perpetual or steady system.

II. Ganoulis - Inclusion of social and environmental considerations to the technical performance and economic effectiveness under *4E-paradigm* as,

a. Epistemic - Social and technical reliability
b. Economic - Economic effectiveness
c. Environmental impact
d. Equitable - Social equity

Relationships are as illustrated in the following schematic diagram.



III. Butler & Parkinson - A truly sustainable drainage system is an idealized and unattainable goal because of human over consumption. The strategies for more sustainable drainage systems are,

a. Separate runoff flows of polluted waste water.
b. Avoiding mixing of industrial wastes with domestic sewage.
c. Reducing reliance on water as transport medium for waste.

Summary of Failure, Diagnostic and Rehabilitation of Urban Infrastructure:

Small and large scale changes in hydrologic systems caused by urbanization are the recent concerns of researchers and government agencies worldwide. Research in this area has traditionally addressed the issues of storm water runoff, flood assessment, lower infiltration, increased runoff due to impervious surfaces, depletion of water resources etc. now, it has become mandatory to bring topics associated with aquifer- and catchment scale-scale contaminant hydrology and water quality. The frequency of associated failures of facilities can be estimated through risk analysis as summarized in the following table.

Failure Type	Structural	Hydraulic	Environmental
	Subsidence	Flooding	Combined sewer overflow
	Total or partial collapse	Surcharge	Strom sewer overflow
	Corrosion	Leakage/inflow	Pollution of receiving waters
	Loss of soil support	Increased roughness	
	Loose bricks	Water hammer	
	Soft mortar	Flow instabilities	
	Other structures interference		
Diagnostic	Monitoring	Monitoring (levels, flows)	Monitoring (occurrence of CSO's, quality in receiving streams)
	Sewer survey (man entry, TV inspection)	T V inspection	SWMM model (calibration/verification)
	Infrared scan	Storm water management and transport model	
	Penetrating radar		
Rehabilitation	Maintenance	Maintenance	Storage inline and offline
	Repair	Increase flow capacity	Treatment
	Renovation/renewal	Flow attenuation/reduction	Inlet control
	Lining	Storage in line/off line	Flow accumulation/reduction
	Replacement	Inlet control	Aeration
		Lining	Source control
		Real time control	Real time control
		Replacement	Replacement

Best management practices:

In addition to fulfill the criteria of sustainability the system needs to be adaptable to future environmental quality objectives and demands. Furthermore, physical sustainability also requires socioeconomic sustainability so that the systems financing is compatible with the long-term ability of the community to pay for it.

In the US, the EPA has mandated that most municipalities with a population larger than 10,000 must obtain *Storm-water discharge permit* for the implementation of

structural and non structural arrangements suiting to local conditions. The ASCE task committee for evaluating BMP's has developed a guide that examines permanent structural practices for retrofitting the storm water system existing in developed areas. The type of the pollutant to be removed, land availability, ground water levels, soil types and construction & maintenance costs are some of the design factors included in the process.

The project's original long-term goal, which remains the central focus of the project, is to gather transferable technical design and performance information, to improve BMP selection and design so that local storm water problems can be cost-effectively addressed. Original project tasks included

1. Develop a set of recommended monitoring and reporting protocols for BMP monitoring studies.
2. Design and create a national storm water BMP database.
3. Collect existing BMP design and performance data, evaluate it to ascertain if it could meet the protocols and, if so, enter the data into the BMP Database.
4. Develop a recommended data evaluation approach.
5. Evaluate the data entered into the database and report initial findings.

In the UK BMP's are referred as Sustainable Urban Drainage Systems (SUDS). Advances in Scotland in more than 1300 approved schemes have its significant effect in rest of the country. SUDS are also providing benefits to biodiversity and the wet land environment by creating habitats as a result of retaining water in a swale or a pond that supports some plants along with invertebrates. The incorporation of some simple design refinements can produce gains for bio diversity. For example, permanent water depth of 0.5m or less will support the greatest array of plants, while depths over 1m is suitable for special habitats. Some of the important BMP's as listed by Urban Water Resources Council are as follows.

Structural BMPs

This information must be completed for each structural BMP in a test watershed. The data requested vary according to the following common groups of BMPs: Detention Basins, Manufactured Devices, Retention Ponds, Infiltration Basins, Percolation Trenches/Dry Wells, Porous Pavement, Wetland Basins, Wetland Channels/Swales, Grass Filter Strips, Media Filters, and Green Roofs. An Other BMP category is also provided to enable flexibility for entry of BMPs that may not fit a pre-defined category. Most of the parameters requested in the structural BMP tables are required in order to compare the effectiveness of various BMP designs. All BMP-specific design forms are located at the end of the spreadsheets in the workbook, with each BMP type having a separate worksheet.

Non-structural BMPs

Non-structural BMP data requested are generally narrative/descriptive information on the type and extent of BMP practice being implemented, as well as cost data. Non-structural BMPs have been divided into the general categories of education, maintenance, recycling and source controls. Evaluating non-structural BMP characteristics is new ground for many. Defining measurable (i.e., quantifiable) parameters for non-structural BMPs is an evolving science. When more than one non-structural BMP is employed, it can be extremely difficult, if not impossible, to isolate the effectiveness of one BMP from the effects of other non-structural BMP(s) being tested at the same site. Also, a significant amount of data is needed to discern differences in water quality results between comparable watersheds with and without non-structural BMPs. For this reason, nonstructural BMP testing programs will typically need to take place over more than one year. It is likely that confounding variables will be difficult to identify and to isolate in non-structural BMP tests. The Non-structural BMP design forms are located at the end of the spreadsheets in the workbook, with each BMP type having a separate worksheet.

Few examples parameters of BMP's are as shown in the following table.

Best Management Practices (BMP) Categories	
Structural	**Nonstructural**
Biofilter	Maintenance practice
Detention basin	Education
Hydrodynamic device	Recycling
Medial filter	Source control
Percolation trench/well	
Porous pavement	
Retention pond	
Wetland basin	
Wetland channel	

Impact Control:

To control the impact on the receiving waters EPA uses a criterion called *Total Maximum Daily Load* (TMDL), which is the maximum amount of pollutant that a water body can receive and still meet water quality standards. It is calculated as the sum of the allowable loads of a single pollutant from all contributing point and non point sources. A factor of safety must be included in the calculation. The clean water act requires the development of TMDL's for water bodies that do not meet water quality standards in order to specify the load reductions for each pollutant of concern, so as to meet applicable water quality standards.

Sedimentation:

One of the leading causes of water quality deterioration in rivers and lakes is sediments. This deterioration can be divided into problems resulting from a chemical constituent absorbed onto the surface of the fine grained sediments, problems resulting from sediment quality and alteration of the substrate by erosion or deposition. The USDA National sedimentation laboratory is in the process of developing a strategy based on sound procedures to facilitate the development of TMDL's for clean sediment in streams.

In drainage systems and in combined sewers in particular sediment deposits create negative effects on the hydraulic performance of the system and on the environment. The modeling of the sediment and the associated pollutant transport depend on accurate runoff modeling. Until now chemical and bacteriological processes have played a limited role in the engineering of drainage and combined sewer system, inclusion of these contributes to sustainability. For an integrated and sustainable drainage system considerations are

- The sources water and waste water
- The sewers as a physical and biological reactor
- The interaction of the treatment plant
- Impact on the local receiving waters

Development of integrated models is still a challenge, *"the main bottleneck is the complexity of the total system that prevents the simple linkage of the existing deterministic models of the individual subsystems to an entity"*

Conclusion:

John F Kennedy has once send "*a person who solves the problem of water is worthy of two Nobel prizes, one for science and other for peace*". This so true with growing population and ever growing demand for more and more water, this seems to be unattainable for the reason that we are working against equilibrium of the nature. We hear about the loss of rivers, lakes, wetlands, depletion of well fields, water quality degradation etc., why are the results of many models and regulations are not positive, many reasons, one reason is, models, tools, regulations have been applied in a compartmentalized way rather than an integrated way, perhaps models have been applied at the right scale, or have been applied outside their realm, integrated approach that will not compromise the sustainability of the water resources and the ecosystem within a watershed. The evaluation and application of BMP's and TMDL's are very important in judiciously using our resources.

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SCARCITY OF WATER
WILL BANGALORE FACE ITS NATURAL DEATH?

Capt. S. Raja Rao
Former Secretary, Minor Irrigation, GOK

Everyone knows Bangalore as "Garden city", Silicon Valley" and "Air – conditioned city". These adjectives for Bangalore City appear to be a thing of the past. A fear is lurking among many enlightened men that "the water scarcity will force a natural death for Bangalore". Following are the strong reasons for the above sentiment:

1) The data published by Govt. of Karnataka, during 2005 after a scientific study carried out by the Mines and Geologies Dept. in association with the Central Ground Water Board has classified **Bangalore Urban District** as well as **Bangalore Rural District** as "**Critical**" as far as the availability of ground water is concerned. This means that already in these two districts ground water is "mined". This clearly suggests that any further sinking of bore wells in these two districts will be at the peril of the existing bore wells and in the days to come, the existing bore wells also will either dry up, or the yields will diminish drastically.

2) In the **"State Water Policy"** published during January 2002, it has been stated that due to indiscriminate use of ground water more than **3 Lakh bore wells** have become dry and expenditure to the extent of over **Rs. 2000 crores** spent on providing pumps, pipelines etc. have **become a waste**.

3) The State Cabinet has recently approved a bill called **"The Karnataka Ground Water (Regulation and Control of Development and Management) Act of 2006."** This Bill is likely to be passed during the current session of the assembly. In terms of this Bill, the areas in the State will have to be notified as "specific areas" in the publicinterest to control and/or regulate the extraction or the use or both of ground water in any form, in any area. It will advice the Govt. to declare any such area as "a notified area" for the purposes of the said Act with effect from such date as may be specified therein and the Govt. will have to notify such areas accordingly. This Act also provides for the constitution of "**Ground Water Authority**." Under the provisions of this Bill, the **Ground Water Authority** will definitely not permit or grant new permissions for sinking bore wells in "notified areas", which is already declared as "**Critical**" by Mines and Geology Dept. Thus, on passing of this Bill by the Assembly and bringing it under the Statute Book, use of ground water in Bangalore Urban and Bangalore Rural District is not at all possible. This means, that for the requirement of water for any new development work in these two districts will have to depend entirely on "Surface Water".

4) The metro-project for Bangalore City for a length of about 10 kms is running underground by 10-15 mtrs. Similarly the proposed road below ground level in two stages from Minc Circle to BDA Circle and beyond will be cutting across the existing **Dykes and Faults** passing through these areas. The disturbance of these existing Dykes and faults will have "Telling Effect" on the movement of ground water in this area. All the existing bore wells on the down stream side beyond the intersection points of these dykes and faults by either the metro rail or by the underground roads will become dry and the existing users will be totally disturbed as their existing water supply through their bore wells will come to a stand still. This serious effect on ground water resource should have been examined in the EIA report prepared for such projects. Unfortunately the new EIA notification dated 14th September 2006 brought out by MOEF, GOI has not included such infrastructural projects taken up by local authorities (BDA, BBMP, BMRDA etc). This serious omission is being taken advantage by the above authorities and they are not preparing EIA/EMP and even if such reports are prepared the said projects are not coming up for "Public Hearing" under the EIA notification. Consequently the public is kept under dark. The above two projects is likely to create a **grate harm** for the already depleting limited ground water resources of Bangalore City and countless number of existing bore wells will become defunct and the expenditure incurred on them will become in fructuous. The State Environment Department, Mines & Geology Department, KSPCB have to take this issue seriously and ensure that proper remedial measures are incorporated to minimize the damage to the existing ground water resource of Bangalore City.

5) Cauvery Water Disputes Tribunal (CWDT), in its final award, dated 05.02.2007 has done great injustice to the state and in particular to Bangalore city regarding drinking water. As per the National and State Water Policy, "Drinking Water" gets the highest priority. Even though Tamilnadu was not a "Basin State" in Krishna Basin, the three basin states were generous enough to provide 5 T.M.C. each for drinking water to Chennai city. Tamilnadu Govt. forgetting the gratitude extended by this State, had argued before CWDT to restrict the benefit of Cauvery water to Bangalore city to only to the population residing in the Cauvery Basin and according to CWDT award, only 1/3rd of Bangalore city is lying in the Cauvery basin, and to that extent the population living in the 1/3rd basin is provided Cauvery water as per their order. Tamilnadu Govt. has **lost a golden opportunity** to win the hearts of Kanndigas by not reciprocating the benefit they have received from Karnataka for Chennai drinking water supply. Tamilnadu Govt. was fully aware that from time immemorial the entire Bangalore City was getting water from the Cauvery River and a big chunk of Bangalore populations are Tamilians.

6) As per the CWDT award, 8.7 T.M.C is provided for urban population and 8.52 T.M.C. is provided for rural population for drinking purposes. Out of the total 17.22 T.M.C., 50% is considered as available from surface water and accordingly allowed 8.75 T.M.C. as our share from Cauvery Waters. The State had sought 28 T.M.C. of water required for domestic and industrial use, and we are provided only 8.75 T.M.C. According to the accounting formula, when we use 8.75 T.M.C., 20% of this, namely, 1.85 is accounted against our total allocation of 270 T.M.C.

7) CWDT has considered requirement of Water for drinking purposes as under:

a) 25% of urban population at 135 lpcd.

b) The remaining 75% of urban population at 100 lpcd.

c) For rural population and for animal population, the rate provided is at 40 lpcd and 30 /lpcd respectively

d) 50% of the Water required are assumed to be from ground water and remaining 50% from Surface Water.

e) The population projection considered for allocating water is upto 2011.

CWDT's norms are much below the norms prescribed by the National Commission for integrated Water resource Development Plan. This Commission has worked out the Water requirement as under up to 2050 AD.

1) Class I cities – 220 lpcd
2) Other than Class I cities 220 lpcd
3) Rural areas 150 lpcd
4) For animal population 18 to 30 lpcd
5) 70% of urban, 30% of rural water requirement will be met from surface water

The above Commission has submitted its report during Sept. 1999. This is the latest report of the National Commission. The recommendations of this Commission should have been considered by CWDT while working out the water requirements. Such exercise would have benefited the State and Bangalore City by providing more water from Cauvery River. This mistake needs to be corrected by WRDO as the Review Petition before CWDT is still pending.

8) The entire Bangalore City is depending for its water from Cauvery basin through Thippagondanahalli Reservoir as well as different stages of Cauvery schemes undertaken by BWSSB. It is to be noted that CWDT has "not protected" the present use of 14.20 TMC of water drawn from Cauvery river under different schemes mainly because, the Tribunal has recognised only 1/3rd area of Bangalore city is falling under the Cauvery Basin and accordingly the

population living in this 1/3rd area of Cauvery basin for which drinking water from Cauvery river is provided. The total quantity we can use not only for Bangalore but also for other towns and cities and industries located within Cauvery basin, that can be drawn in a "Hydraulic year" is to be limited to 8.75 T.M.C. only. This quantity is already being drawn and utilised. Thus, as per CWDT award, there is no scope to drawn further water from any of the rivers in Cauvery basin for domestic and industrial purpose. This means that we cannot have any additional water from rivers in Cauvery basin. This will bring to an end all future industrial and urban developmental works in the Cauvery basin.

9) Since National and State Water Polices has given top priority for "Drinking Water", all future needs will have to be met either by economizing and improving the efficiency of the existing use, or by cutting down some of the existing irrigation use. This particular issue is very sensitive and it affects the farmer directly. **The question that needs to be asked is why additional burden and pressure should be put on the depleting water resources for the future development at the cost of existing irrigation use by the farmers. This particular issue will create serious problems for the Govt.**

10) BMP has been enlarged to BBMP, bringing 7 CMCs and 100 villages into its fold. All of them are aspiring for Cauvery Waters. The new International Airport is depending for its water for all its future use on Cauvery River. The new Metro Project and subsequent Mono-Rail Project also need substantial water from BWSSB which in turn depend on Cauvery River. The new satellite towns (5 nos), Ramanagar Town being developed as District HQ, housing, Rajiv Gandhi Health University all need Cauvery water. Innumerable Private Builders have already developed large areas for habitation and apartments. BDA, BMRDA, Karnataka Housing Board are planning large residential areas putting great demand for more Cauvery Water. The number. of Ring Roads, Peripheral Roads, Interconnecting ring roads etc have increased the horizontal extent of Bangalore development. As per the revised Master Plan for Bangalore city the existing area from about 250 Sq. KM has been extended to nearly 800 Sq.Km there by permitting vast expansion of Bangalore city and all this expansion needs additional Cauvery Waters. The industries department is increasing the industrial area and many SEZ's (Nandagudi) are being formed for new industries. All these developmental activities will come to a grinding halt due to lack of water. BWSSB has said that it can not commit to supply water to Nandagudi SEZ. The question to be asked is where do we get water for Bangalore city for all these developmental activities? From the availability of Ground Water point of view, already Bangalore Rural and Urban Districts are classified as "Over exploited" and the "New Ground Water Bill" will not permit drawl of any further ground water. CWDT has put a cap on our use of surface water in Cauvery basin. How can the new

developments can take place? Should not the Govt. address this issue seriously and find early solutions? Why Govt. is hurrying through these developmental packages without under standing that "Water" is a basic infrastructure, essential for all these developments.

11) For issuing no objection certificate for New Industries and Housing Projects, Karnataka State Pollution Control Board (KSPCB) is not recognizing ground water from bore wells as source for water. If bore wells are indicated as source, KSPCB is not approving such projects and, instead are insisting that "NOC" be obtained from BWSSB for providing required quantity of Surface Water.

12) In turn BWSSB, when New Industries or a New Builder approaches them for issue of NOC for providing required water, BWSSB after collecting huge fees is giving NOC stating that "the required quantity of water will be provided, if available, not before 2011/2012", i.e., after commissioning Cauvery IV Stage, Phase II Project. The water available from this project is also limited to the extent of 500 million liters per day. This quantity will not be able to meet the increasing demand. Thus there is a "definite limitation" on the availability of Cauvery water from BWSSB.

13) From the above, it is very clear that no new developmental work, i.e., industry, new layout, new township, Metro rail project, Monorail project, International Airport, new SEZ's etc will not have permission to use Ground Water, no new bore wells will be permitted, and fresh surface water connection form BWSSB or from any river/reservoir in the Cauvery basin will not be sanctioned immediately and water will not be provided before 2011/2012 A.D. This clearly means that all developmental works in and around Bangalore city in particular and in Cauvery Basin in general will have to either totally be given up or will have to be slowed down to match with the availability of the surface water. **Thus, it is obvious that scarcity of water in Cauvery basin in general and for Bangalore City in particular will hasten the death of Bangalore City.** The State Govt. has to give top most priority to redress this problem with a workable proposal backed by adequate finances.

POSSIBLE SOLUTIONS

14) BWSSB has put up number of sewage plants. The treatment efficiency is under cloud and the treated effluent is not meeting the standards prescribed by KSPCB. BWSSB has entered into MOUs with few firms and agreed to part with substantial quantity of treated sewage for their further use. Excluding this quantity, and substantial quantity flowing in the primary drainage, BWSSB should collect all the sewage and link all the missing links to the trunk sewer

and treat the entire sewage received at all the treatment plants satisfactorily and upgrade the existing treatment units to "**Tertiary level**" and collect the Tertiary treated water in underground reservoirs. BWSSB should plan and execute "Parallel Pipeline" to supply the "**Tertiary Treated Water**" to the public for their regular use. This exercise can only be successful after educating the public repeatedly and taking them in to confidence and preparing them well in advance to use the tertiary treated water for all purposes excluding drinking and cooking. This exercise needs time, effort, and persuasion. On its success, the pressure on "fresh Cauvery water" will come down. This exercise is inevitable for the survival of Bangaloreans and to support only an "**incremental growth**" and not the type of development being planned at present by BDA, BBMP, BMRDA, HOSING BOARD, INDUSTRIES DEPARTMENT, INTERNATIONAL AIRPORT AUTHORITY & SEZ etc.

15) In this connection it is worth while to keep in mind that in the neighbouring state of Tamilnadu, the Metro Board Chennai executed a Sewage recycle treatment Plant to supply the treated water to industries using Japanese Aid. This project was undertaken after consulting industries. However as the plant progressed and was nearing completion, the industry backed out and were not ready to use the treated Sewage water and the entire scheme executed at huge expense has become infracutous. Therefore BWSSB has to carefully consider the option of supplying "**Tertiary Treated Water**" to Bangalore city without adequate preparation.

16) The continued availability of Ground Water depends on the Rain fall, the geology of the area and the efforts made for Ground Water Recharge. The efforts of the State Government on Rain Water Harvesting and Ground Water Recharge are acting only as popular slogans and the seriousness in implementation is lacking. The High Court committee under the Chairmanship of Capt.S.Raja Rao has made several recommendations. The Recommendation No. 75, (for details see Para 21, page 152 of 5th bi – monthly report) deals with the "**Construction of recharge structures for harvesting rain water and re-charging ground water by BMP at road intersection points."** This Recommendation has been accepted by BMP for implementation and an affidavit is also filed before the Hon'ble High Court of Karnataka. Inspite of giving an affidavit BMP, now BBMP is yet to take action. This recommendation is helpful for re-charging the groundwater not only for Bangalore City but also for the entire state in general and for towns and cities in Cauvery basin in particular. The State Govt. should view this lapse of BBMP very seriously and issue circular instructions to all authorities for implementing this recommendation on top most priority.

17) At present expect Thippagondanahalli Reservoir the water supply for

Bangalore City is depending on Surface flow in the Cauvery River and there is no "**dedicated**" storage reservoir. The CWDT Award has put a cap on usage of water in the Cauvery Basin and prohibited growing summer paddy, Limited Sugar cane production to 40,000 acres, prohibited all lift irrigation schemes and restricted use of water for "Drinking Purpose" in the Cauvery Basin. As against a demand of nearly 275 TMC of water for irrigation Projects (KRS, Kabini, Hemavathi, Harngi, Anicut channels, Nugu and Devaraj Urs Canal) CWDT has allowed about 150.57 TMC of water only. On implementation of this Award the quantum of "**return flow**" and "**base flow**" in the Cauvery River will get substantially reduced. This reduction is bound to affect the continuous availability of "Surface Water" for Bangalore City . Depending on such depleting surface flow for the increasing Bangalore City population is very dangerous and the availability of drinking water will suffer. Therefore there is a need to assure availability of drinking water for Bangalore City continuously. CWDT has allowed construction of 3 dams **one in Karnataka at Mekedatu** and **two in Tamil Nadu at Hognekal**. The construction of these dams will take sufficient time after getting all the statutory clearances. It may take anywhere between 5-8 years for completion of this project. The State Government should evince at most importance and give top most priority to get this project cleared and execute it in a time bound manner and complete it at the earliest so that Bangalore citizens can have a "Sigh of relief" for the assured drinking water. **The State Government should prevail upon CWDT & Government of India and get an early clearance for this project. Due to the fact that the required water has to be lifted by an additional 100 mtrs height from " Mekedatu Reservoir" all the beneficiaries will have to be ready to pay increased water rates once the water is supplied from the Mekedatu Reservoir. Perhaps this is the prize the Bangaloreans have to pay for the "Short sighted" vision of the State Government and BWSSB.**

18) Bangalore city is the Capital of Karnataka. It is IT, BT city. With the International Airport, the growth of Bangalore city is obvious. **Development without water is not possible**. **There is a need to look for alternate water source for Bangalore city. The State Govt. should constitute immediately a multi-disciplinary expert committee to study this issue and come up with appropriate recommendation for getting additional water into Cauvery basin at different locations keeping in view the future developmental activities with population projection upto 2050 A.D.** The possibility of **getting water from West – flowing rivers appears to be bleak because of serious environmental problems**. The next best alternative is to get water from **Almatti Dam**. The committee to be constituted should examine all these alternatives, and come up with the best solutions. Three months time may be given to the Committee to come up with their recommendations.

19) Till such time the availability of water, the cost of getting such water, the time frame for executing the project is correctly assessed and funds earmarked, the present pace of development of Bangalore city needs to be stayed or slowed down. Any development without assuring water will be an infructuous expenditure for which the State Govt. alone will be responsible. **If the required quantity of additional water, is not ensured & the present pace of development is allowed the days are not too far the public to say that "Scarcity of Water will cause Natural Death for Bangalore City".**

20) **National Concern**

The National Commission for Integrated Water Resources Plan 1999 has expressed the following concern:

"Water conservation in every sphere and increase in efficiency of Water use in every Activity should be the overriding considerations in Water Resource Development and Management. The method and means of Water Resource Management should be SUSTAINABALE over time both from the point of view of Development needs and preservation of Environment".

21) **Immediate Plan of Action**

- ✓ Constitute an **Expert Committee** to explore alternate water source for Bangalore City. **(3 Months)**
- ✓ **On priority execute Mekedatu Hydel Project (Minimum Period).**
- ✓ Pass immediate legislation for Ground Water Management and use.
- ✓ Mandate rain water harvesting for all buildings, monitor, discipline and penalized for default.
- ✓ **BBMP to construct Rain Water Harvesting structure at all Road Intersections (2 years).**
- ✓ Provide **Duel Pipeline** for the **new BBMP areas** to supply Tertiary Treated Water.
- ✓ **Educate Bangaloreans** to accept Tertiary Treated Water for **domestic use**.
- ✓ Undertake massive drive for leak detection and its stoppage.
- ✓ **Upgrade all STPs to tertiary level.**
- ✓ **No new Residential Areas/Industrial Areas/SEZ be approved without ensuring availability of Surface Water through BWSSB.**

HOW TO SAVE THE LAKES OF BANGALORE ? - AN ACTION PLAN

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BACKGROUND

According to the Survey and Settlement Records of the Government prepared in early 1930s, even today there are 937 Lakes, Tanks and Water-bodies in the Bangalore Urban district which largely coincides with the 790 km^2 area of the Brihat Bangalore Mahanagara Palike (BBMP). The area of the tank-bed of these water-bodies is 26,468 acres. However, due to the population pressure, unscrupulous action of encroachments and debris-dumping by vested interests, wilful action of Government in breaching tanks and allotting to various organizations like ISRO, Medical Colleges, Stadiums, etc, and the illegal action of forming sites and allotting them by civic bodies like the Bangalore Development Authority (BDA), letting untreated domestic sewage into the lakes and the like, the area lost in the tank beds is a conservative 2,000 acres according to a preliminary survey by the Survey and Settlement and the Revenue Department of the Government of Karnataka.

What was once a scientific system of "cascading of lakes" – water flowing from the higher levels to lower levels and ultimately to the natural drainage and river systems – has now become unrecognizable and an urban eye sore. It is well-known that this loss of lakes blocking the natural storage and draining of water causes environmental diseases, floods, water stagnation leading to damage to roads, unusability of lake water for drinking water purposes, etc. This paper briefly examines steps to recover, protect, clean-up and maintain the lakes.

A MYRIAD AGENCIES HAVING JURISDICTION OVER LAKES

The following are the various Government departments and statutory bodies which are having legal powers and authority to protect the lakes:

a) Revenue Department
b) Public Works Dept.
c) Forest Dept.
d) BBMP
e) BDA
f) BWSSB
g) Pollution Control Board (KSPCB)

h) Lake Development Authority (LDA)
i) District Magistrate (Deputy Commissioner)

Every one of the above agencies have legal powers to protect and maintain lakes given over to them. The Government of Karnataka formed in 1985 an Expert Committee under the Chairmanship of late Shri N.Lakshman Rau IAS (Retd.) who was once the Administrator of the Bangalore City Corporation, with the objective of examining all drawbacks and problems relating to preservation and restoration of tanks existing in the then Bangalore Metropolitan area and make suitable recommendations. After the Committee submitted its report, the Government, accepted all its recommendations and issued a Government Order No. PWD 82 IMB 85 dated 11-2-1988. The recommendations of the Committee which were incorporated in the Government Order are:

(a) The **46 disused tanks** should be handed over to the Horticulture and Forest Departments and Ornamental Parks and Tree Parks should be raised in these unused tank beds;

(b) The **81 Live Tanks** should not be breached but should be protected by foreshore planting and they should be used for irrigation or for recreation purposes to preserve environment;

(c) The **262 tanks in the Green Belt** should be protected and maintained as the 81 Live Tanks;

(d) The Forest Department exclusively to preserve 90 lakes for and 24 other lakes should be preserved jointly by the Forest Department and Karnataka State Tourism Development Corporation (12), BDA (6), BWSSB(4), Minor Irrigation (1) and BBMP (1);

(e) In addition to Cubbon Park and Lal Bagh, six to eight Regional Parks should be developed in disused tank beds, if necessary by acquiring additional adjoining lands:

However, inspite of a specific Government Order and the powers under the different legislation and even the Code of Criminal Procedure enabling the District Magistrate (Deputy Commissioner) and the Sub-Divisional Magistrate (Assistant Commissioner) to punish persons encroaching or damaging public space including Lakes, very little action has been taken by these agencies to protect the lakes. On the other hand, the Government and statutory bodies like the BDA have themselves breached and used them for buildings and sites many tanks (e.g. Kodihally, Chikamaranahally, Challaghatta, Kalagondanahally, Kadirenahally, Kurubarahally, Kacharakanahally, Saneguruvinahally, Sarakki, Binnamangala and Gaddarahally, to mention a few) exemplifying the adages, *"Fence Eating the Crops"* and *"Who Will Guard the Guardians ?"*.

CONSEQUENCES OF DESTROYING LAKES

The well-known consequences of destroying lakes in the exploding urban Bangalore, to repeat are, flooding after a 50mm rain, environmental diseases and malaria, drying up of drinking water sources (till 1972 many of these lakes were such sources), ending the "salubrious climate" of Bangalore, disappearance of a sanctuary for birds, fish and animals and the like. A former Chief Minister of Karnataka used to boast he will make Bangalore the "Singapore of India" after which hordes of Ministers and Officers visited Singapore as a result of which while Bangalore has not become Singapore, it is likely that these visiting dignitaries have made Singapore a little like Bangalore. Had the boasting been to make "Bangalore, India's Venice" it would have been achieved because after one rain the roads of Bangalore become canals and many persons including children have started drowning.

The population of Bangalore has been increasing at a compound rate of 4.9% annually since 1970 (and the vehicle population, especially motorized two-wheelers, at 15%) according to a World Bank Report of 2005 studying the transport problem of Bangalore and Chennai. At this rate of growth, by 2018, Bangalore's present population of 75 lakhs (2008) will increase to 1.15 crore and its vehicle population will increase from its present 35 lakhs to 1.23 crores. The damage to civic life in Bangalore due to the disappearance of lakes will be incalculable in this future city of Mass Immobile Metal. There is no concern about this ticking time-bomb by either the Government, citizens or Voluntary Organizations as these numbers do not register in our minds.

HIGH COURT ORDER PROHIBITING ALLOTMENT OF TANK-BED LANDS

In 1995 a Writ Petition No.31343/95 was filed in the High Court of Karnataka by four leading citizens – an environmentalist and former Vice Chancellor, Army General and Principal Chief Conservator of Forests – against indiscriminate grant and unauthorized occupation of tank bed lands in and around Bangalore. The Hon'ble Justice Eshwara Prasad passed an interim order on 22-8-1995 directing the Government not to make any grant or allotment of lands situated within the Bangalore Metropolitan area. The order is still in operation. But Government have been violating this order with impunity as the Departments are not even aware of this Court order.

SUGGESTED CONCRETE ACTION TO RESTORE, PROTECT AND MAINTAIN BANGALORE'S LAKES

A) LDA TO BE A STATUTORY BODY: Firstly, as the plethora of agencies having all the legal and administrative powers to protect the lakes has not succeeded, it is necessary to vest legal powers in the Lake Development Authority. The LDA is now only a Society registered under the Karnataka Societies Act headed by the Chief

Secretary and the only one of its kind in India and it has no teeth. Its sole reason for existence is to protect, maintain and develop the lakes. Since coordination among the existing agencies with legal powers is notoriously not achieved in practice, it is necessary to convert the LDA into a Statutory Authority (like the BDA, BWSSB or BBMP) and vest in it all the powers, both enabling development schemes and punitive powers to prosecute persons encroaching or damaging lakes. For getting the required stature in this hydra-headed multiplicity of urban agencies and bureaucratic hierarchy, the LDA should be headed by a full-time Official Chairman of the rank of Additional Chief Secretary with a Governing Council of Fifty, consisting of heads of urban bodies in Bangalore, leading environmentalists and Voluntary Organizations meeting mandatorily once in a quarter and a smaller Executive Committee of about Twenty which should meet and review progress of action at least once in a month. The LDA as a statutory body should have powers to exercise all the powers of the existing urban bodies in so far as lakes are concerned and also should have powers to direct the existing urban bodies to implement lake-protecting measures under their own legislation.

B) LDA TO PREPARE A MASTER PLAN FOR LAKE DEVELOPMENT: The LDA should prepare a Master Plan for all the 1,500 or so lakes in the Bangalore Metropolitan Area which consists of all the taluks of the composite Bangalore district, including BBMP, (Bangalore Urban, Bangalore Rural and Ramanagaram districts) as the entire Bangalore composite district is fast becoming urbanized if not a Megalopolis and Conurbation already. The Master Plan should cover a period of 10 to 15 years to be implemented to cover all aspects of protecting, developing and maintaining the lakes. Such a Plan would require enormous funds. For instance, the Bellandur Lake alone, which is the biggest lake in Bangalore having about 915 acres of tank bed area, requires about Rs.25 crores to clean up and maintain according to the Consultancy Report prepared by the Voyants Solutions for the BWSSB. Such a comprehensive Lake Protection and Development Plan would require funds in the range of Rs.25,000 crores. The LDA should therefore prepare the Master Plan for seeking assistance from Government of India funds such as Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and from international funding bodies such as the World Bank, Asian Development Bank and the Japan Bank of International Cooperation. Preparation of such a plan would require consultation with environmental and other voluntary organizations, leading citizens, Town and Country Planners among others and the consultants to prepare the Master Plan should be selected through Global Tender.

C) GOVERNMENT TO STOP ALL "REGULARIZATIONS" OF TANK BED ENCROACHMENTS: To prevent Bangalore, which was once described as the Land of Thousand Tanks, from becoming a Land of Thousand Sewage Tanks, all these lakes should be restored by stringent measures of removal of encroachments. It should be mandatory that encroachment in tank-beds, lakes, water-bodies and Raja Kaluves should not be regularized. Such regularization should not even be thought of because, apart

from rewarding law-breakers and inducing further encroachments, it will destroy whatever remaining mild climate of Bangalore and pave way for uncontrollable flooding and environmental diseases and will destroy the very future of Bangalore. There is no point in taking a soft view that "Poor people for their livelihood" have encroached upon tank beds and some other "Innocent Persons" have purchased plots in these tank beds from bogus documents prepared by unscrupulous middle-men and corrupt officials. Where public interest of saving a city is concerned there is no place for such misplaced sympathy and misdirected generosity.

Those belonging to the Below-Poverty-Line classification who have encroached upon tank beds and water-bodies and built hutments and dwellings on small sites of 20 ft x 30 ft or so can be given sites in the Government's Revenue Department land and BDA land encroached in Bangalore Urban district which is as much as 21,706 acres and 2,878 acres respectively. Especially, the Revenue Department has been auctioning the lands recovered from encroachment to builders and realtors. Instead, first preference should be given to allot such revenue lands recovered from encroachers to these tank-bed encroachers below Poverty Line and slum dwellers on removal of such tank-bed encroachments. Similarly, the 2,878 acres of BDA land under encroachment should be recovered by the BDA and the BPL tank-bed encroachers can be allotted sites in these recovered lands.

D) POLLUTION CONTROL BOARD SHOULD PERFORM ITS DUTIES. The Karnataka State Pollution Control Board has enough powers under the Water Act to prosecute and close down the establishments of the polluters. However, in not a single case has the PCB been able to bring these cases to the stage of filing charge sheet, let alone securing punishment. It is seen that the PCB is concentrating selectively in issuing notices to industrial polluters and completely neglect the damage to tanks and lakes which is going to affect the health of the citizens of Bangalore.

There is a long list of environmental diseases caused by water pollution. Apart from mosquito breeding and malaria, Bangalore already suffers from asthmatic and respiratory disorders caused by flower pollen. According to the National Institute of Environmental Health Sciences, the long list of diseases caused by environmental deterioration are Asthma, Dermatitis, Emphysema, Goiter, Lead and Mercury Poisoning, Nervous System Disorders, Osteoporosis, Pneumoconiosis, Queensland Fever, Tooth decay, Vision problems, Xeroderma Pigmentosa, Yusho Poisoning and Zinc Poisoning. Therefore, unless the Pollution Control Board prevents immediately the conversion of Bangalore's tanks and lakes into Sewage Tanks and sump-drains, this city will become a cesspool of filth and foul matter causing major health diseases. The PCB should therefore use its enormous powers to protect the environment and ecology of Bangalore for which duty it is amply empowered.

It should insist on all the apartment buildings to install Secondary Treatment Plants (STPs) which costs not more than Rs.20 per square foot of built up area which is

insignificant in the cost of over Rs.1,500 per square foot of apartment flats. This will also lessen the burden on the BWSSB to provide scarce drinking water which is now being used for non-potable purposes also.

E) DIVERSION OF SEWAGE ENTERING LAKES AND BIO-REMEDIATION TECHNOLOGY: There are proven methods of diverting sewage entering lakes (as in the case of Ulsoor Lake cleaning up done a few years ago) and constructing "Box Drains" to restore the lakes. Also, the Clean-flow technology of Bio-Remediation under which oxygen is pumped into the tank bed to kill the weeds and adding beneficial bacteria and enzymes to keep the lake water clean even if some sewage enters through storm-water drains overflowing into the lakes, should be taken up. There is no one single, silver-bullet solution, solution to lake protection. All known methods as practiced in various parts of the world should be followed.

F) STEPS TO BE TAKEN UNDER EXISTING LAWS:

The Revenue Department: The Karnataka Land Revenue Act has been amended in 2007 under which an encroacher of any government land can be prosecuted and is liable for an imprisonment of a minimum of one year which may extend upto three years besides fine. Hence, the 2,488 encroachers of tank bed lands who have encroached 1,848 acres of land according to the survey of the Revenue Department should be prosecuted and punished, besides removal of encroachment including buildings and fixtures constructed on them.

The **Forest Department and the Pollution Control Board** should use its enormous legal powers to protect the tanks and tank-beds under its control instead of shirking its responsibility take the responsibility seriously and protect the lakes entrusted to them.

The **BDA, BBMP, BWSSB and KSTDC** which also have been given 24 tanks to be maintained should take the responsibility seriously and protect the lakes entrusted to them.

G) A HIGH LEVEL REVIEW COMMITTEE: A high level Committee under the Chief Secretary or Additional Chief Secretary should be formed to review the progress of action on the above lines. Besides the officers it should also contain prominent environmentalists, leading citizens and Voluntary Organizations involved in lake matters and civic affairs. Such a Committee should meet at least once in a quarter.

MERGING ECOLOGICAL AND LEGAL ASPECTS IN CONSERVATION OF ARKAVATHY BASIN

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Abstract

Human beings have always depended on aquatic resources for food, medicines and materials as well as recreational and commercial purposes such as fishing and tourism. Not only that, aquatic resources are considered as a heritage of a nation. In addition, aquatic ecosystems have significant impact on migratory bird species that use the water bodies as sanctuary and stop-over for food, breeding and nesting. The main outputs emanating from the environmental destruction of the Arkavathy basin include sewage pollution, illegal encroachment on wetlands, illegal quarrying and sand mining (mud-lifting) on the basin floor, deforestation of catchment zones, the use of heavy detergents in laundry works in the water bodies, brick making factories, etc. The impacts of Arkavathy basin management have been described in the context of their micro-watershed zones. Therefore Conservation of our water resources should be taken in the context of a human right. The Indian constitution recognizes the basic fundamental right of its citizens; the right to a clean and healthy environment. Pre and Post Stockholm Laws must now be enforced along with a biodiversity-inclined restoration with the new impetus to protect our water resources.

Keywords: Arkavathy, Micro watersheds, Environmental enforcement

INTRODUCTION

Water is cradle of life. It is a basic human need and a finite life support system. To protect this precious resource, one needs a stringent enforcement system meant for its conservation, sanitation and supply. Environmental laws are meant to set standards for what people and institutions must do to control or prevent environmental pollution including water. After enactment it becomes the job of the central and state governments to make sure that those who are subject to these environmental protection laws know what they must do to comply. In this case there are central and state institutions called the Central and State Pollution Control Boards respectively. Their primary role is the enforcement of the Environmental Protection Act (EPA) and its constituent statutory frameworks dating back to the Post Stockholm environmental laws such as the Water (Prevention and Control of Pollution) Act of 1974. Protection of wetlands in the local enforcement context (apart from the Ramsar Convention issues) is a duty of every citizen of this country.

Human beings have always depended on aquatic resources for food, medicines and materials as well as recreational and commercial purposes such as fishing and tourism. Not only that, aquatic resources are considered as a heritage of a nation. In addition, aquatic ecosystems have significant impact on migratory bird species that use the water bodies as sanctuary and stop-over for food, breeding and nesting. Nevertheless, wetlands are one of the most productive ecosystems which can be compared to the tropical evergreen forests in the biosphere and play a significant role in the ecological sustainability of a region. Moreover, they are life supporting systems providing fishes, forest products, enabling agriculture, water harvesting, improving flood control, maintaining erosion buffering zones, containing plant gene pool, preserve wildlife, as well as providing unique spots for human recreation. Therefore, they have immense socio-economic and ecological importance even in the context of a real urban development planning.

The urban aquatic ecosystems are strongly influenced by long term discharge of untreated domestic and industrial wastewaters, storm water runoff, chemical spills and direct solid waste dumping. All these released pollutants have a great ecological impact on the water quality in the affected watershed regions. In this case, a high degree of industrialization, urbanization, and other anthropogenic activities in Bangalore region has led to the contamination of various micro-watersheds including those within the Arkavathy Basin. This tremendous pressure of urbanization and urban sprawling is severely devouring the rural environment destroying the watershed regions. The degree of destruction varies between districts and taluks of Bangalore. With high population density, shortage of monsoon rainfalls, and increasing water depletion, many fresh water bodies in the basin are now polluted and disappearing. Relaxation in enforcement options have only exacerbated in an unwanted destruction of the Arkavathy basin.

CAUSES AND IMPACTS OF POLLUTION IN ARKAVATHY BASIN

The main outputs emanating from the environmental destruction of the Arkavathy basin include sewage pollution, illegal encroachment on wetlands, illegal quarrying and sand mining (mud-lifting) on the basin floor, deforestation of catchment zones, the use of heavy detergents in laundry works in the water bodies, brick making factories, etc. The impacts of Arkavathy basin management have been grouped in the context of their micro-watershed zones. The main factors influencing human-induced pollution in the **watershed zone** include:

- Excess sediment/silt inputs caused by destructive form of land use and other land clearance activities paving way mainly for housing, quarrying and farming. Sediments destroy wetlands and block penetration of light into the water column thus killing aquatic life-forms. They can also act as carrier of nutrients and other pollutants that favor one array of species against the other causing a disruption of species composition in that local ecosystem

- Excess non-point source nutrient inputs which originate from soil erosion in the catchments. This contributes to algal outbreaks and growth of aquatic weeds. This causes reduced oxygen levels that kill fish and micro-organisms
- Agro-chemical pollution coming from agriculture, horticulture, and other cropping schemes. These agro-chemicals such as pesticides, metal-complexed inorganic fertilizers, volatile organic substances (VOS), poly-aromatic hydro-carbons (PAH) can persist in lake sediments for a long time. The danger is when the surface water volume filters through this sediment load towards the underground aquifers, the chances are the ground water will have been contaminated with those pollutants.
- Excessive water withdrawals or diversions affecting the natural lake inflow volume as against the outflow capacity. Increasing layouts in the basin zones cause an uncontrolled mechanical piercing of ground water reservoirs with large scale extraction of ground water for domestic and industrial purposes. Moreover, the unused or abandoned tube-wells are converted as "flushing-points" to rid off unwanted domestic and industrial discharges.
- Sewage and Industrial pollution caused by direct discharge of domestic and industrial waste from surrounding industries and households. This can add toxic chemicals, BOD, and effluents to a lake basin.

With these problems that started in the upper (catchment) zones of these micro-watersheds, serious consequences to life and survival of the ecosystem emanate down the basin in the water spread regions. The water is exposed to:

- Domestic effluent and storm water discharges caused by untreated or poorly treated effluents from lake shore communities. This exacerbates Biochemical Oxygen Demand (BOD), reduction of Dissolved Oxygen (DO), and increase in bacterial contamination. Other urban contaminants such as oils, organic matter, heavy metals, also add to pollution load in these micro-watershed zones.(e,g, Byramangala, Karihobanahalli, Nalakkaderanahalli, Dasarahalli, Malathalli.
- Shoreline industrial contaminants which can also change physical characteristics such as temperature, turbidity, BOD, COD, DO, etc. These contaminants can also cause ground water pollution. Byramangala and Peenya Lakes are the best living example of how a combination of municipal and industrial pollution can render a pristine aquatic ecosystem into a virtual cess-pool.
- Water extraction through irrigation purposes, causing pollution on crops and also drying of lake aquifers. This is evident in lakes such as Chikkabanavara, Madhavara, T.G. Halli, Byramangala, etc.
- Loss of wetlands and littoral habitats as has now been experienced in a number of recorded cases across the entire stretch of the Arkavathy basin from Hesarghatta to Kanakapura region.

- Severe encroachment of land immediately on the banks of the lakes. Cases in the region have been documented in Madhavara, Malathalli, Ullal, Kengeri Uppanagara, Komaghatta, Ramasandra, etc

So what happens in the water as a consequence of all these activities in the upper catchments and in the in-lake basins? As a result, the aquatic habitats suffer from:

- Severely polluted, heavily turbid and colored water filled with heavy loads of dissolved and suspended matter. This water is rendered as unsuitable for human consumption – either for drinking, irrigation, or animal drinking.
- Unsustainable fishing practices causing decline in fish diversity as well exposing health risks to human consumers. Various fish species are now threatened and it seems now that "Jelebi" is perhaps the dominant variety thriving in an increasingly polluted aquatic ecosystem of the Arkavathi basin.
- The decline in fish productivity causes inexperienced fishermen to resort to introduction of exotic floral species (algal blooms) and faunal species (foreign fish species) into lakes threatening the loss of indigenous fish species as well accelerating the change in micro-floral and micro-faunal species composition, e.g. Malathalli Lake case in March 2009.
- Weed infestations (Water Hyacinth, Amaranthus family, Ipomoea spp.; which affect lake's water quality, interfering in navigation and water flow and sometimes trigger development marsh lands.e.g. Ullal, Kamagondanahalli, Narsipura, Kengeri Uppangara, etc.
- Irrigation of contaminated water into our croplands. As most of the water quality of these tanks fail the standard guidelines required in order to prevent our crops from being contaminated, still the same water is used to water our plants regardless of the dangers and risks facing our consumers.
- The ground water extraction itself becomes an imminent danger to the people. As most water testing facilities do not have adequate resources to check all the industrial contaminants that may have percolated underground and into the region's ground water aquifers, it is hard to ensure a citizen these days of the impending dangers of ground water contamination in his/her back-yard bore-well.

CASE STUDIES ON SOME MICRO-WATERSHEDS OF THE SOURCE OF THE BASIN

Bagalkunte:

This combination of two adjoined lakes is situated inside Bagalagunte Village at Hesarghatta, 8th Mile Main Road, behind BMP Office and is known as Site No. 83 and 113 respectively. The immediate lake area is 4.7743 Ha. This series connect to Hesarghata which is the command area and the connections can be improved by

channelizing the area up to 600 acres of this site. Previous records show that the lake was partially polluted then with 22 encroachment cases booked. It was recommended then that the lake zone should be fenced; desiltation of the lake bed should be carried out along with the cleaning and strengthening of the bund. In addition, planting of tree species should be carried out.

The lake is surrounded by poor people and mainly by daily wage workers who are engaged in construction and agricultural activities. The water and sanitation networks are not fully and well developed and people use the tanks for sanitation calls. The lake is dry and without water apart from the sewage pond that has grown out of the surrounding domestic waste water discharges. Encroachment is so severe that permanent houses have been built on the larger portions of the southern area of the dry lake bed (S. No. 83) and on the bund itself.

The northern zone of the lake (S. No. 113) is still intact, though completely dry. Waste water manholes are conspicuous inside the dry lake bed, The BBMP had planned for a road on the bund but Forest Department had put a case and stopped the work. This bund connects the two adjoined lakes. There is an illegal graveyard next to the lake. Ironically this site is also shared with a dump yard and for ground water extraction using the bore wells. Drinking water supply pipes are seen next to sewage drains. Surplus way of the BBMP has been breached. There is one “raja kalave” which has been strengthened to improve the water inflow by the BBMP. They have also formed storm water drains. A local person named Chikkanna said that there was plenty of water 10 years back; but sanitary connections are only given now.

Several dominant floral species of conservation importance are seen on the banks and inside the tanks. These species include Acacia sp.; Calotropis sp.; Indian Date Palm Tree; Ficus sp.; Ipomoea sp.; Pongamia sp.; Kare; Cactus plant; Cocos nucifera; Parthenium; Polygonum sp.; (ziziphus jujube); etc.

Major threats to the tank include no proper sewage management system around the village and, naturally the entire unaccounted sewage flows untreated into the tank’s basin. Most of the village’s solid waste is dumped out in the open along the banks of the tank. This includes domestic garbage; earthern materials; and plastic bags. Encroachment has already cost the existence of the lake S. No. 83. It is also evident that Site 113 is also being highly encroached with houses built right on the bank of the tank with sewage outlets discharging their contents directly into the tank. The graveyard right next to the tank poses a serious threat to the surrounding ground water resources. This has the potential to contaminate the extracted ground water and hence threaten the lives of the villagers who depend almost entirely on the ground water bore wells for their drinking and cooking purposes.

Evidence of extraction of the tank’s sand/soil is conspicuous. Sand Mining threatens the water retention capacity of a tank to store a requisite volume of surface water enough to support the aquatic biodiversity of the area. This is synonymous to “perforation” of a basin.

It was recommended that: Legal action to be taken against all responsible for physically encroaching Site No. 83. -Immediate Fencing of the Site No. 113 was to be initiated. - Blocking of all domestic sewage pipes emptying into the tanks should be carried out. - Diversion of major sewage channels to avoid contamination and hence pollution of the lake; Prevention of all illegal activities around the catchment such as solid waste dumping; sand mining; uncontrolled grazing; unaccounted ground water extraction activities around the basin. With this, it was also suggested that a development plan should include Rain water harvesting (underground storage to help supply drinking water for the surrounding areas); Development of two island sanctuaries for avian diversity; - Desiltation in areas where sand mining has affected the natural depth of the tank; BWSSB and BBMP, Asst conservator of forests should prepare a report along with map and a report to be given by this core committee and the committee will give its action report.

Chikkabanavara

The lake is located towards the east of Chikkabanavara. Its registration number is 510. Its original area was 40.50 ha. The recent estimate suggested that the tank area was reduced to 27.52 ha. The Karnataka State Remote Sensing Application Agency has calculated the area to be at 33.0829 Ha. Possible depth of the lake is up to 10 ft deep. Previous records from the Forest Department described the lake as free from weeds and protected from developmental activities. The Forest Department recommended that the lake should be fenced, desilting works carried out, bunds strengthened, plantation, and repairs of weirs to be carried out. The KSPCB water pollution monitoring report in the year 2000 stated that the lake had an incredible 7.7 mg/L Dissolved Oxygen which was well within the optimum life supporting conditions of an unpolluted lake system. The Biochemical Oxygen Demand was below 3 mg/L in most sampling stations of the lake. Inorganic Phosphates were below 0.4 mg/L while average Nitrates concentrations were at 1.2 mg/L. Sulphates were at an average 8.8 mg/L.

Nowadays, the lake is almost completely dry save for the deep zones which still retain water holes crucial for drinking animals and small scale fishing. The entire basin is intact and with no severe encroachment. The eastern bank is bordered with a Eucalyptus plantation, Coconut Groves, and Acacia Trees. Peepal Trees, and Indian Date Palm Trees are dominating the bund zone of the lake. These are also called as Heritage Trees or “ashwatha kattae”. They act as ecological indicators, ecological purifiers, spiritual shrines, and birds’ sanctuaries. The fruits of Peepal Tree are said to purify water when falling in it. It is also said that a lake with such trees around it is compared with River Ganga. It is very important to note that it destroys flies in water. There is a higher scope for restoration and Forest Department has taken care of the encroachment. Lichen can be seen growing on the trees which indicate good air environmental quality of the site. All king’s canals are intact. The lake is more than 300 years old. It is reported that in this area, one acre costs 1.5 Crores.

Plants of ecological significance documented in the immediate periphery of the lake include mangoes, peepal trees, Heppe (bassia latifolia- Maduca Indica), Euphorbia-Croton, Neem, Calotropis, Ipomoea, Castor Plants, Rain Tree, Acacia, Eucalyptus, Coconut Trees, Lichens, Honge Plants, Indian Date Palm Trees, Dattura Mettel, Dodonia, Neem, Lantana, Pongamia, etc. The lake is used primarily for agricultural purposes although there is a sign of development of residential and other layouts on the catchments around the lake. A brick making unit is seen on the western fringe of the lake. There are no signs of intensive socio-economic pressures in the vicinity although the highest catchment peak has now been extensively cast open for construction and other quarry activities.

Threats facing this micro-watershed include open casting of catchment areas. This is the highest point of the area and effectively a critical catchment zone for rain water. This hill top has been completely cast open. This resulting soil erosion and silt movement poses a danger to the lake ecosystem as well as its bathymetric profile. The demand for housing construction and land reclamation poses a new danger for the lake as evidence of some mining inside the lake's bed is visible.

After joint inspection it was recommended that a Joint survey of the catchment area to be put to action and assess the level of encroachment around the lake; immediate steps to be taken to stop sand mining inside and around the lake's basin. It was vital to prepare a plan to channelize water for minor irrigation department; - prepare a plan to divert more water into the lake; planning for restoration of flood gates/sluices and weirs; carbon dating to be done to estimate the age of the heritage trees around the lake; removal of silt; and restoration of check dams.

Kamagondanahalli:

The name is derived from the local word "soil smell". The tank's registration number is 508. It is located behind the Government High School, Abhigere Village. The lake's surface area was 11.29 ha. According to BBMP, the lake's area was reduced to 6.34 ha; but the present Karnataka State Remote Sensing Application Center's calculation gives the tank's area up to 9.5077 ha. Previous records from the Forest Department showed that the lake was partially polluted with weeds with some case of encroachment. The department recommended works to be carried including fencing, desiltation, strengthening of the bund, repairing of waste weir, planting, and diversion of channels. This lake series reaches catchment at Chikkabanavara. The Entire village is dependent on ground water from this lake. About 100 years back the water was used for drinking.

The lake is at its normal water level. The lake is severely encroached from almost all sides. Waste water manholes tower above the water inside the tank and even inside the 'cascade" outflow channel links that form the Hesarghatta hydrological series. The lake is evidently alive with avian diversity indicating its critical ecological potential in

supporting biodiversity. The lake provides a good source of fresh water fishes in the area – this is one of the reasons for the presence of large diversity of birds in the location. Animal grazing is also seen around the lake. There was no sign of Eichornia Crassipes in the tank. The tank is also rich with *Sylvia sp.; Pistia, and Amaranathus sp*. Also Honge; convolvulaceae; Coconut Trees; Indian Date Palm Trees; Calotropis sp.; Acacia sp.; Banana plantations; Areca Trees; Sylvia sp.; Mango Trees; Honge Plants; Castor Plant, Pongemia; Dodonaea ujube , Cyperus sp,etc have been recorded on the immediate periphery of the lake

The following are major threats to the tank: Destruction of Catchments - Being part of the series around Hesarghatta area, the destruction of catchments such as that at Chikkabanavara also affects the survivability of Kamagondanahalli lake as well. Siltation and soil erosion from upland terrains can destroy the environmental quality of this lake and reduce the volume of the tank's water. Severe encroachment by construction and agricultural activities is threatening the lake's immediate basin and its life forms. The banks of the lake bear evidence of the solid waste dumping. This includes a heavy load of plastic waste which can be fatal to cattle and bird who use this lake for drinking and food.

After joint inspection, it was recommended that: Fencing to be done immediately; all sewage and waste water inlets should be identified and blocked immediately; De-weeding should be carried out to reduce the level of infestation; B W S S B , BBMP, and Forest Department should organize a joint inspection visit to assess the waste water trunk line. Restoration and protection and development of wetland storm water drains should be replaced; Desilting is not required here. But a little bit of improvement for birds by creating sanctuaries and tree parks should be done; T r e e park and kalyani (water holes) should be developed; and a joint of the nearby land and survey of sewage inflow/outflow should be carried out.

Abigere

The original area of this tank given by BBMP was 8.0 ha. The KRSAC calculated the area of the tank to be 17.4090 ha. The lake is totally dry and without water except for a few greenish and polluted water holes that still provide fishing as the source of food for the nearby poor residents. The lake bed has got a fine sand, evidence of the economic potential of the area that also harbors quarrying activities from the nearby catchment rock in the upland terrain on the left side of the bund. Alongside that quarry area, there is a huge solid waste dump site with huge amount of earthen waste materials. Encroachment is severe all round the lake with people having resorted to build even on the leeward side of the bund. Sand mining inside the dry bed is rampant. Graveyards have been illegally established on the upper banks. Bore wells have been constructed beside this grave yard.

Several dominant floral species of conservation importance are seen on the banks

and inside the tank. These species include Acacia sp.; Calotropis sp.; Indian Date Palm Tree; Ipomoea sp.; Pongamia sp.; Honge; Tamarind Trees; Cocos nucifera; Lantana sp.; Polygonum sp.; (ziziphus jujube);

Judging on the settlements around the tank, the lake is surrounded by both high and low income groups of people engaged in quarrying, construction, grazing, and other small scale agricultural activities. These activities pose an environmental catastrophe of the lake. Quarrying is destroying the catchment around this lake. This disfigurement of the basin could be responsible for loss of water harvesting potential of the basin and hence drying up of the lake. A solid waste dump has completely encroached the lake's bank from the left side of the bund. A milestone has been established to assert a right of claim of an owner who encroached this area. Leachate from buried waste can also pose a grave danger to ground water. Encroachment in the form of houses, grave yards, grazing site, quarrying, waste dump, is visible. The graveyard right next to the tank poses a serious threat to the surrounding ground water resources. This has the potential to contaminate the extracted ground water and hence threaten the lives of people. Sand Mining disfigures the lake and threatens the water retention capacity of a tank to store a requisite volume of surface water enough to support the aquatic biodiversity of the area. This is synonymous to "perforation" of a basin.

It was recommended that iImmediate demolition of encroaching structures to be carried out; fFencing of the entire lake area to be carried out to keep off unwanted activities such as fish and birds poaching, sand mining, defecation, grazing, and burial activities; Quarry and dump site towards the lake catchment to be sealed off permanently.

Doddabomasandra

The lake is located at Vidyaranyapura .The original area as given by the BBMP was 46.44 ha. The area was reduced to 40.90 ha. Presently, the area estimation by KSRSAC gives the lake area at 38.2536 ha. The lake was restored under the Indo-Norwegian Environment Program (INEP) at a cost of Rs. 340.96 Lakhs. The lake was later put under Schedule B of the Public Private Participation Policy of the Lake Development Authority (LDA) for expression of interest on Development Operate and Transfer (DOT) basis. Three applicants showed their interest in taking up the lake under the DOT Scheme Schedule B. These were M/s District Supply and Marketing Co-operative Society Ltd, Bangalore Urban; M/s Subash Projects and Marketing Ltd, B'Lore; and M/s SIMCO Constructions Private Ltd; B'lore. The Government of Karnataka allotted Rs. 7.72 Lakhs towards Chain Link fencing Work around the lake.

The lake resembles a shallow marsh land with short grass and visibly used mainly for open grazing of cattle. The waste water sluice gates have broken down and this poses a danger of letting the sewage water drain back into the restored tank. Moreover the sewage channels have been physically smashed at some points to connect sewage

lines coming from the surrounding residential layouts. Encroachment is evident in several points of the lake. There is almost free and unhindered movement of people in and around the lake. Although the faunal biodiversity is visible with a large contingent of avian diversity inside the tank, there is little or scattered vegetation in and around the lake apart from the grass and other small plant species. Solid waste dumps are visible in many points of the banks of the tank. Some land of the forest department has been encroached to build an apartment.

There is a rich avian diversity in the tank but apart from small grassy vegetation inside the tank such as amaranthus, very few trees are seen around the lake include Castor, eucalyptus trees, Honge Trees, etc. During the inspection, a long brown water snake, about 7ft in length was spotted swimming inside the shallow marshes of the tank. The lake is located between a residential layout on one side and a business district on the other. It is also exposed to open vehicular traffic.

Some layouts have had to smash the concrete sewage drains to channels their discharge into the main divert channel. These gates were designed to check the inflow and outflow of sewage in efforts to protect the lake from sewage pollution. These gates are not working properly and this is threatening a possibility of the sewage being pumped back into the lake. The lake has little or no dense vegetation cover. This reduces the ecological significance of the lake is supporting a complex food web. Neglect makes people to use the lake for dumping purposes. This threatens higher pollution levels into the lake.

It was recommended that: Sluice gate to repaired immediately; Fencing to be implemented without delay; aAction to be taken against encroachers and dumpers; The islands should be developed by planting higher trees to improve dense vegetation cover; The broken sewage channel points should be sealed back and action against violators should be taken.

Tindlu:

The lake is located behind Vidyaganapathi Temple, Vidyaranyapura. The temple is constructed in the lake. The original area as given by the BBMP is 16.20 ha. At present the lake is reduced to 6.38 ha. The KSRSAC gives the lake area at 4.765 ha. The lake was developed with state funds between 1999 and 2000. The lake was desilted; wetlands constructed; sewage channels diverted; and bird islands constructed with jogging path and paragola. Also fencing was done. The lake has no water and, like Doddabomasandra, resembles a shallow marsh land with short grass and visibly used mainly for open grazing of cattle. There is a visible presence of dense vegetation cover around the lake. The lake is intact and requires small scale restoration works such as cleaning and removal of boulders from the lake bed.

There is a rich floral diversity around the tank. They include Honge; Neem Trees; Wild Date Palm Trees; Eucalyptus; Acacia; Coconut; Peepal Trees; Cyperus; Mango

Trees; etc. The fence is breached and the banks of the lake are encroached by apartments and villas. Grazing of cattle inside the lake is also visible. Neglect of the lake makes people to use the lake for dumping purposes. It was further recommended that: fencing to be implemented without delay; aAction to be taken against encroachers and dumpers; The islands should be developed by planting higher trees to improve dense vegetation cover.

Narsipura Tank

The lake is located inside BEL layout, Vidyaranyapura. The tank registration number is 350. The original area as given by the BBMP is 8.51 ha. The KSRSAC gives the lake area at 3.3634 ha. The lake was developed with state funds between 1999 and 2000. The lake was desilted; wetlands constructed; jogging paths constructed; handle bridge built and fencing done. A Bird island was also constructed.

The unique feature about this lake is that a Sewage Treatment Plant (STP) to accommodate sewage management of the surrounding BEL layout was constructed to treat the waste water before releasing it into the a constructed wetland before reaching into the water spread zone. At the outset, the project was hailed as one of the best sustainable, green technology in trying to save the urban lakes. But the sewage facility broke down and started pumping untreated and raw sewage directly into the lake. What followed was a mutual accusations between BBMP and BEL on the responsibility of repairing the sewage facility.

Despite its biodiversity richness and permanent water capacity, the lake is severely polluted with extreme levels of eutrophication. There is a severe weed infestation including water hyacinth, amaranthus and blue-green and brown algae. The lake surroundings have been turned into domestic solid waste dump sites.

There is a rich floral diversity around the tank. They include Bamboo, Amaranthus; Eichornia Crassipes; Honge; Neem Trees; Wild Date Palm Trees; Eucalyptus; Acacia; Peepal Trees; Cyperus; Mango Trees; etc. Water fowls and other birds are also visibly present in the lake. The Dysfunctional Sewage Treatment Plant (STP) poses grave ecological danger and serious human health risk if not contained and repaired. Neglect of the lake makes people to use the lake for dumping purposes. It was recommended that the broken STP should be immediately repaired; and fencing to be strengthened.

WHAT ISSUES SHOULD BE TACKLED TO SAVE THE BASIN?

We have always been focusing more attention on ecological engineering of restoration specifics (even when these engineering methods have resulted more on negative impacts in the ecology of the watershed zones than its positive effects) than on the holistic approach of the entire problem itself —the legal obligation of prevention of such destructive factors. All this time we have stood on the fence watching helplessly

as serious environmental crimes are committed against our wetlands. In this scenario, where we have grown accustomed to unethical restoration of our micro-watersheds with little effective results and often in the name of "beautification" and "desiltation", it is like treating a victim of a crime without punishing the culprits who committed such a crime. Nevertheless, even when it comes to treatment — we apply wrong and sometimes perilous medicines of treatment. What is left of our yearning for solutions is not only in the academic institutions and engineering board rooms, but back to the constitutional tools that empower our nation and people to intervene in the name of law.

Conservation of our water resources should be taken in the context of a human right. The Indian constitution recognizes the basic fundamental right of its citizens; the right to a clean and healthy environment. Article 21 of the constitution insists that no person shall be deprived of his/her life or personal liberty except according to the procedure laid down by law. By this article, the Supreme Court of India in the case of *Subhas V State of Bihar* held that the Right to Environment is a fundamental right of every citizen in India as included in the right to live. The ruling states that the State has the responsibility to protect the environment as laid down under the Article 51-A(g) of the Constitution of India. In other words, the Supreme Court underscores the fact that environmental rights indeed are human rights and they constitute everything from civil, political, economic, and social rights of people and communities in general. This link is inseparable. Therefore there is an obligatory duty on the part of law makers of the state and the country to ensure that the right to water involves the mandatory protection of our water resources.

The Use of Common Law on Water Pollution:

Common Law in India continues to be enforced under the Article 372 of the Constitution of India in so far as it is altered, repealed, or amended by a competent legislature or other authority. People can fight environmental crimes, and especially water pollution crimes under the Law of Torts. The Tort liabilities for environmental pollution were and still are made available under the context of Public Nuisance, negligence, and Strict Liability; and Damages & Injunctions. Remedies found on Public Nuisance law include criminal prosecution for the offence causing public inconvenience; criminal proceeding before a magistrate for removing pubic nuisance; and civil action by advocate general or by two or more members of the public with permission of the court declaration, injunction, or both.

In 1987, M.C. Mehta successfully used Damages remedy in *M.C. Mehta v Union of India* in a Shri Oleum Gas leak case. Mehta argued for the principle of "absolute liability" (Polluter Pays Principles) as laid down in an 1868 England Case known as *Rylands v Fletcher*. Earlier the court held that the rule laid down in *Rylands v Fletcher* was more than a century old and that it could no longer address the current problems fully. But Supreme Court of India ruled that when an industry is engaged in a hazardous

or inherently dangerous activity (to environment) the enterprise is strictly liable to all those who are affected by that incident without any exception as laid down in *Rylands v Fletcher*

The Use of Post Stockholm Laws in Fighting Water Pollution:

Until the coming of the Environmental Protections Act, 1986, prosecutions under the Indian environmental laws could only be done by the Government. Public interest groups or citizens had no statutory remedy against a polluter who discharged effluents beyond legally permissible limits other than those in common laws. But now, under the Section 19 of the EPA, a citizen could now use the law to prosecute any polluter/ company BUT provided that a 60-Day notice was given of the intent to prosecute. Based on this provision the Water Acts were amended to fall in line with the above EPA provision. Section 49 of the Water (Prevention and Control of Pollution) as amended in 1988 provided that new window of citizen's enforcement of environmental laws of India other than those of the common law.

Public Interest Litigation:

A PIL is a constitutional right. Article 32 and Article 226 of the constitution empower a citizen to move the Supreme Court and High Courts, respectively, for a direction to the State for restoring a fundamental right. PIL came into existence in the early 1980s when reformist and activist judges such as P.N. Bhagwati and V.R. Krishna Iyer started creative interpretations of the law to allow citizens not directly affected by an injustice to file petitions in court on behalf of those less privilege and therefore unable or reluctant to approach the court. This ushered in a new genre of cases known collectively as Public Interest Litigation. M.C. Mehta cases perhaps bear the highest tone of judicial activism never seen before in the legal aspects of environmental enforcement. A landmark M.C. Mehta case was the petition that moved the Supreme Court for prevention of nuisance caused by the pollution of River Ganga in order to protect the lives of the people who make use of its waters. Moreover, in *Indian Concil v Enviro-Legal*, the Supreme Court of India entertained a petition of the people living in village due to sludge waste left out by closed-down industries which caused heavy damage to the environment. The Court ordered a remedial action be taken and compensation be given to for the silent tragedies in line with the Mehta's "Absolute Liability Principle"

THE ROLE OF ENFORCEMENT AGENCIES

Any Environmental legislation is based on resources and tools for enforcement. Any pollution control authority must require instruments for such regulatory approach.

These include a variety of economic incentives; fair, efficient, relevant and updated regulation with accompanying environmental standards and norms; effective guidelines for enforcement and effective public participation.

For a long time since 1974, many polluters have disregarded the directions of pollution control boards and violating the conditions of consent with impunity. This is because since from the start, PCBs have not been fully empowered to exercise coercive powers of their own; and most part of this comes form the clash of jurisdiction of powers. The core of contention is the fact that PCBs face hostile legal provision for penal action against polluters.

Overdependence of the legal system is perhaps one of the major problems engulfing enforcement actions by the PCBs. Unlike several other countries such as the US, UK, Canada, and Australia where regulatory agencies have clearly defined mandate to prosecute polluters without approaching the courts of law, in India, PCBs are required to approach the judiciary for this purpose. This often encourages legal wrangling by polluters. In accordance to the EPA, the PCB must file a case before the lower court for action against a polluting unit and therefore the "onus of proof" is always vested with the PCB. The fact is lower courts are too busy to devote enough time for environment related litigations, unlike in the case of Supreme Court and Green Benches of Higher Courts. As a result, thousands of legal cases filed by PCBs against polluters are still pending for many years. Nevertheless, in the number of cases where decisions have been reached, polluters have been given benefit of the doubt because of failure of PCBs to satisfy the courts with the "onus of proof".

Polluters also engage in prolonged legal wrangling even after convictions to escape deterrent penalties. They recruit highly paid professional lawyers to plead with their cases whereas the PCBs are disenchanted with the legal procedures. This is why most PCBs would rather go for an arbitrary decision by taking direct action as under Section 33(A) of the Water (Prevention and Control of Pollution) Act, 1974. This sometimes comes with heavy legal consequences against the PCB, as seen in the following examples:

For example, in *M/S/ Delhi Bottling Co Pvt. Ltd v Central Pollution Control Board (1986),* the question was whether the procedure under Section 21 of the Water (Prevention and Control of Pollution) Act, 1974, was necessary to collect legal samples for analyses under section 33 of the Act and whether the sample had been collected according to the procedures required for collection of a legal sample as under Section 21(5) of the Act. The Delhi Court held that Section 21 was not properly followed by the PCB and therefore the sample was not admissible as evidence. Also in *Mahabir Coke Industry v Pollution Control Board*, the PCB directed the closure of industry as per Section 31(A) of the "Power to Give Directions". It was held by the court that the sample was not taken in accordance to the Act.

Another example of legal wrangling is in *Mandhu Distillery Pvt Ltd v M.P. Pradhusahn Niwaran Mandal (1995)*. A question was whether Section 33(A) of the Act

which explains a power of a board to direct closure of industry and regulation of electricity was restricted or not. The court ruled that the respondent (PCB) issue fresh show cause notices and take samples for analysis to issue proper directions.

In *M/S Suma Traders v Chairman, Karnataka State Pollution Control Board*, the case was whether the Chairman of the KSPCB had any competence under the Act to pass any order under Section 31(A) and Section 15 of the Act. The court held that the Chairman acted in arbitrary manner and that this was a misuse of statutory powers. The PCB's order was suspended by the court and so the Chairman as his personal liability had to pay Rs. 2,500/- to the petitioner.

CAN CITIZENS BE ACTIVELY INVOLVED?

It is important to note here that citizens have been explicitly excluded from legal monitoring and enforcement action. Their public participation has been limited to a few areas such as PILs; public hearings for EIA; and under Citizen's suits. Somehow there is a feeling in from the public viewpoint that many post-Stockholm statutes have connived in letting a polluter use legal loopholes and get away with their environmental crimes. What underlines this opinion is the fact that citizens are not allowed to present legal samples in a court of law.

A development of a citizen's enforcement culture is therefore a very important step. In the face of administrative inefficiencies in environmental investigations and law enforcement, our present environment desperately needs citizen's help. It is much cheaper and more efficient to develop citizen's involvement in a fight against environmental crimes. Certainly, any citizen would know what is going in their locality. They can easily identify pollution situation and hence identify a pollution source. Citizens can work with the PCBs in obtaining documents on the suspect industries under the right of information provision; they c an also check whether something is being done about an environmental problem in their locality. Since we have recognized environmental laboratories across the country, citizens can approach local or nearby environmental laboratories for identification of a pollutant, its sampling and subsequent analysis. Contacts to various regulatory agencies such as the PCB can be established in case of a pollution problem. Eventually, a citizen can proceed with legal action by exploring various judicial gateways.

CONCLUSION

It is clear from the above accounts of various legal environmental aspects that both pre-Stockholm and Post-Stockholm provisions are as much important when mutually taken into account as they would be if taken separately. There is a need to improve penalties in common law provisions so that they cam match up with the impact of environmental crimes. Bar of jurisdiction as laid down in the Water and Air Acts should

not be allowed to interfere with the Common law jurisdiction. Justice is a fundamental right of every citizen and so it is important that citizens should be empowered to present legal sample in the court of law. The right to know is a basic pillar for environmental justice and denying a citizen that right is equal to denying the citizen the right to fight pollution crimes. Despite their success, PILs still do not entirely gives a citizen the right of claims or compensation. Moreover, in India, many environmental lawyers are classified under the 'pro bono" .

The most important part in the post-Stockholm statutes is the ability of citizens to pursue environmental justice in various legal gateways one of which involving the inclusion of the Government Agency in fighting the environmental crime. Pollution Control Boards have been given clear and visible powers to make sure that the industrial facilities comply with the laws laid down and what enforcement is carried out at maximum efficiency. But, clearly, the only way to carry out environmental enforcements is the active inclusion of ordinary citizens in ensuring that the environmental laws of the land are not flouted.

In view of these observations, it is our recommendations that the following be made:

a) **Sewage Pollution:** Diversion of all sewage lines from the lake bodies and indeed from the "nalas" such as the vrishabavati is imperative and necessary. A Buffer zone should be set between settlements and wetlands and all sewage sources around wetlands should be identified and traced using GIS database generation. The current system of allowing a volume of raw sewage into oxidation ponds and then into wetlands before flowing into water spread area is not sufficient and adds to water pollution because of the magnitude, nature, composition, and volume of raw sewage entering wetlands. Mechanized STP treatment systems are now a must to treat the raw sewage before entering the wetlands.

b) **Encroachment:** It is important to declare a universal rule on the demarcation of buffer zones that would be free of any form of anthropogenic influence – domestic, industrial, or agricultural – from the shorelines. Encroachment prohibition should also include illegal connection of sewage lines from domestic and industrial sources. The buffer zone should be demarcated clearly and information on the status stored in GIS Databases. Reforestation in these zones should be encouraged and the wetlands be declared as lung spaces for carbon sinks.

c) **Quarrying in Wetland Zones:** Due to rapid growth of the city and its physical expansion of population and settlements, quarrying in urban and peri-urban centers and especially alongside the wetlands and catchments should be prohibited. Quarrying destroys physical feature of the catchment basins and increases soil and sediment influx into the wetlands. Immediate prevention of open cast quarrying sites within wetlands should be carried out. The sites

should be rehabilitated and protected from being turned into land fills.

d) **Sand Mining in Lake Beds:** Sand mining of lake beds is a mortal threat that not only threatens to destroy the aquatic, micro and benthic biodiversity of wetlands, but also "perforates" the lake's original lake bed floor. This affects the surface water volume balance of the lake water and results in reduced water retention capacity. Moreover, the filtering capacity of the lakes in ground water recharging is affected. Sand Mining therefore should be prohibited and measures enforced to protect shallow lakes from being exposed.

e) **Deforestation:** Deforestation erodes the catchment basins of important floral diversity needed to control floods and absorb pollutants in water before they reach lakes should be protected from deforestation. Deforestation also leaves the catchment bare and precipitates influx of soil and sediments, and other pollutants. This can be done through controlling resource exploitation of wetland resources and preventing encroachment and grazing.

f) **Brick Making Factories:** These factories are responsible for discharge of waste materials and other factory washouts into the lakes. These factories can be as damaging as the industrial effluents as the washouts are allowed to enter fresh into the water. These factories should be prevented from operating anywhere inside the wetland zones.

g) **Suspending Aquaculture and Irrigation associated with studied wetlands:** Given the magnitude of pollution on the studied wetlands, it is imperative to call upon the suspension of all fishing activities in these lakes to allow further studies on the magnitude and impact of pollutants in the fish species with respect to human health. Moreover, further studies on irrigation water coming from these microwatersheds need to be engaged as the present study reveals risk involved in using polluted water coming from these lakes on crops used by human beings.

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GROUND WATER RESOURCES IN ARKAVATHI BASIN

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INTRODUCTION

Arkavathi basin cover parts of Bangalore and Ramnagara districts. Ground water in the basin is mostly in the fractured aquifer as the weathered aquifer has been exploited over the years. As the basin forms part of urban agglomeration, hydrology of the basin is changing fast due to urbanization. This has also affected the quality of ground water in the basin. Therefore, there is need for protecting the precious ground water through proper land use practices, preventing pollution of ground water by point sources, proper waste disposal (solid as well as liquid) and large scale rain water harvesting programme in the basin.

Location: The Arkavathi basin is to the west of Bangalore city, covering parts of city area. It covers an area of 4253 sq.km. The basin is between longitudes 77°12' x 77°41' and latitudes 12°15' x 13°24'.

Geology: The basin is underlined by old crystalline basement rocks. The main rock units are gneisses and granites with intercalation of meta-volcanic, schist and quartzites of Dharwar greenstone belts. At places, lateritic crusts on the Achaean basement are also noticed. Charnockites are also found in the south-western portion of the basin. There are number of dolerite dykes cutting across gneisses and granites.

Hydrogeology: Ground water in the basin occurs under unconfined conditions in the weathered horizon and partly semi-confined conditions in the fractured horizon. Aquifers in the basin have low storage co-efficient. Weathered and unconsolidated aquifers over lying the bed rock has slightly higher storage co-efficient. Dug wells in the area tap ground water from the weathered zone and bore wells are tapping ground water from the fractured zone.

Geomorphology: The basin is characterized by undulating landscape with rolling topography. The land forms have undergone extensive pedi- plantation leading to a landscape of low relief with granite inselbergs. Out crops of closepet granite often form several meters height and look like large plugs. In the basin, two different topographical units can be distinguished. The northern part is a plateau at an average elevation of about 900m above MSL with shallow valleys and a few inselbergs. The highest relief

is formed by Nandi hills where the river Arkavathi originates. The southern and western part of the basin has more pronounced relief. The south-western boundary of the basin is formed by massive granite hills. The river Arkavathi joins the river Cauvery at the southern tip.

Drainage pattern: Arkavathi river flows in the north to south direction. The stream pattern in the southern and western parts is angular indicating structural control. The main stream is joined by number of tributaries. Lower order streams form dendritic pattern.

Climate: Climate in the basin is generally salubrious. Lowest temperatures are recorded during December and January. Temperature increases gradually during the subsequent months. Maximum temperatures are recorded during April / May. The mean annual rainfall is 840 mm. There is variation in rainfall from year to year and also from station to station. South west monsoon is during the months of June to October & forms the main rainy period.

Vegetation: Agricultural activity is important in the basin. Traditionally, crops are grown during the monsoon and winter season. Rain fed crops are ragi, pulses and oil seeds and paddy is grown in tank commands. As a result of increased bore well irrigation, cropping pattern has changed. In bore well commands crops like mulbery, sugarcane and other cash crops are grown.

Ground water monitoring: The Department of Mines and Geology (DMG) and the Central Ground Water Board (CGWB) are monitoring the ground water levels in the basin through dug wells and bore wells. The frequency of monitoring is monthly by DMG and quarterly by CGWB. . Over a period of time dug wells have become dry and are being replaced by bore wells. Both the organizations have installed digital water level recorders (DWLRs) in some of the monitoring bore wells. Ground water levels and ground water temperatures at a frequency of 6 hr. are being recorded in these DWLRs. Shallow ground water levels are recorded during September / October and deep ground water levels are recorded during April / May months.

Computation of Ground Water Resources: basin Arkavathi has been divided into four sub-basins and ground water resource estimation has been carried out by DMG & CGWB. Annual recharge has been computed by adding monsoon and non monsoon rainfall recharge, return recharge from irrigation and seepages from surface water bodies, canals and water conservation structures. Annual ground water availability is computed by deducting unaccounted natural discharge from annual recharge as suggested in Ground water Estimation Methodology – 1997 (GEM-97). The annual recharge details are shown in Table-1.

TABLE 1. GROUND WATER RESOURCESPOTENTIAL OF ARKAVATHI BASIN MARCH-2004

Sl. No.	Code of the water shed	Recharge from Rainfall during monsoon season(HAM)	Recharge from other sources during non monsoon season (HAM)	Recharge from Rainfall during Non monsoon season (HAM)	Recharge from other sources during non monsoon season (HAM)	Total Annual Ground water Recharge (HAM)	Natural Discharge during Non Monsoon season (HAM)	Net Ground water Availability (HAM)
1	4B3B5	3111.58	1474.35	1471.16	1083.34	7140.43	357.02	6783.41
2	4B3B6	565.01	3540.65	866.31	682.73	5654.70	282.73	5371.96
3	4B3B7	2020.62	609.36	467.13	968.62	4065.73	203.29	3862.44
4	4B3B8	3023.52	3982.33	1400.74	2517.66	10924.25	546.21	10378.04
Total		8720.73	9606.69	4205.34	5252.35	27785.11	1389.25	26395.85

Projected Ground water resources as on march 2004:Ground water resources are computed as on March, 2000 and the same is projected for March, 2004. For the purpose of computing resources for 2004, draft has been projected by taking projected population and ground water abstraction structures. As per the Minor Irrigation Census 2000-01 data, it is observed that during the initial period of the decade the growth rate was very high and it is very less during 1999-2001. Considering these factors a growth rate of 5%for bore wells is used to determine the projected number of structures and irrigation draft. Ground water extraction necessary for domestic and industrial purposes has been estimated using rate of growth of population. The stage of development and categorization are shown in Table 2.

TABLE 2. STAGE OF DEVELOPMENT ARKAVATHI BASIN

Sl. No.	Code of the water shed	Net Ground water Availability (HAM)	Existing ground water draft for irrigation (HAM)	Existing ground water draft for domestic and industries (HAM)	Existing ground water draft for all uses (HAM)	Allocation for domestic and industries for next 25 years (HAM)	Existing Stage of development (%)	CATEGORY
1	4B3B5	6783.41	12165.32	723.28	12888.60	1005.36	190.00	OE
2	4B3B6	5371.96	7647.11	509.36	8156.47	708.01	151.83	OE
3	4B3B7	3862.44	6589.26	208.13	6797.39	289.30	175.99	OE
4	4B3B8	10378.04	17126.95	899.79	18026.74	1250.70	173.70	OE
Total		26395.85	43528.64	2340.56	45869.2	3278.37		

The summary of ground water resources of Arkavathi Basin is as follows.

1. Net annual ground water availability	=	26395.85 HAM
2. Exisiting ground water draft for irrigation	=	43528.64 HAM
3. Exisisting ground water draft for domestic and industrial water supply	=	2340.56 HAM
4. Exisiting ground water draft for all uses	=	45869.20 HAM
5. Allocation for domestic and industrial water supply for next 25 years.	=	3253.33 HAM
6. Net ground water availability for future irrigation development	=	Nil
7. Stage of development	=	172.70 %

CONCLUSION

The **Arkavathi** river basin suffers due to the large-scale pollution from untreated sewage let into the river from the urban area. There are different types of industries, which are discharging effluents into the river. The river has lost its assimilating capacity due to the reduction in the run off generated due to the change in the land use pattern due to urbanization. Net result is that both surface water and ground water in the region are polluted. As can be seen from the ground water resources estimation the entire basin comes under over exploited conditions. This is due to the fact that in the absence of fresh surface water resources there is no alternative except to tap ground water resources for domestic and irrigation needs.

Way Forward: Under the above circumstances it is necessary to avoid mixing of fresh water with the sewage to make rivers pollution-free in turn protecting the ground water from contamination.Large-scale artificial recharge measures may be initiated in the basin to abate the already polluted groundwater aquifer system. All efforts should be made to treat the sewage generated and reuse the same instead of letting it in to the river. Stringent action may be taken against the industries, which are polluting the river from the effluents. Proper monitoring system may be put in place to asses the damage already caused to the water resources due to the pollution and take immediate measures to rejuvenate the river.

ಅರ್ಕಾವತಿ ಸುತ್ತಿ ಬಂದ ಪತ್ರಕರ್ತನ ಅನಿಸಿಕೆ

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ಅರ್ಕಾವತಿ: ಇನ್ನೂ ತಡವಾದರೆ ಬತ್ತಿ ಹೋದೀತು !

ಅರ್ಕಾವತಿ ನದಿ ಪುನಶ್ಚೇತನದ ವಿಷಯ ಕಳೆದ ಒಂದು ವರ್ಷದಿಂದ ಹೆಚ್ಚಾಗಿ ಕೇಳಿ ಬರುತ್ತಿದೆ. ಇಂತಹ ಪ್ರಯತ್ನ ಹತ್ತು ವರ್ಷಗಳ ಹಿಂದೆಯೇ ಆರಂಭವಾಗಿದ್ದರೆ, ಇಷ್ಟು ಹೊತ್ತಿಗೆ ತಾಯಿ ಅರ್ಕಾವತಿ ಮೈತುಂಬಿ ಹರಿಯುತ್ತಿದ್ದಳು. ಕನಿಷ್ಠ ಪಕ್ಷ, 2003ರಲ್ಲಿ ನದಿಪಾತ್ರ ರಕ್ಷಣೆ ಕುರಿತ ಸರಕಾರಿ ಆದೇಶ ಹೊರಬಂದ ಮೇಲಾದರೂ ಸಕ್ರಿಯವಾಗಿ ಕಾರ್ಯ ಆಗಿದ್ದರೂ ನದಿ ಇಂದು ಹರಿಯುತ್ತಿತ್ತು. ಇದೀಗ ಅರ್ಕಾವತಿ ನದಿ ಪುನಶ್ಚೇತನಕ್ಕೆ ಸರಕಾರದ ಮಟ್ಟದಲ್ಲಿ ಚಾಲನೆ ದೊರೆತಿರುವುದು ಸಂತಸದ ವಿಷಯ. ಇದೂ ಹಿಂದಿನ ಪ್ರಯತ್ನದಂತೇ ಕಾಗದದಲ್ಲೇ ಉಳಿಯದೆ ಕಾರ್ಯಗತವಾದರೆ ಅರ್ಕಾವತಿ ಬತ್ತಿಹೋಗುವ ದುಸ್ಥಿತಿಯಿಂದ ಮುಕ್ತವಾಗುತ್ತಾಳೆ.

ಕಾವೇರಿಯ ಉಪನದಿ ಅರ್ಕಾವತಿಯ ಪರಿಸ್ಥಿತಿ ಅರಿಯಲು ಪತ್ರಕರ್ತನಾಗಿ ಹೊರಟಾಗ ಹತ್ತಾರು ಕನಸುಗಳಿದ್ದವು. ಕಾವೇರಿ ನದಿಯ ಉಪನದಿ ಆಗಿರುವುದರಿಂದ ಹೊಳೆಯ ಅಳತೆ–ಪ್ರಮಾಣ ಅಗಾಧವಾಗಿರುತ್ತದೆ ಎಂಬುದೇ ನಂಬುಗೆ. ನೀರು ಹರಿಯದಿರುವುದಕ್ಕೆ ಮಳೆಯೇ ಪ್ರಮುಖ ಕಾರಣ ಎಂಬ ಭಾವನೆವೂ ಮನೆಮಾಡಿತ್ತು. ಆದರೆ, ಅರ್ಕಾವತಿಯ ಮೂಲ ಸೆಲೆ ನಂದಿಬೆಟ್ಟದಿಂದ ಹೆಸರಘಟ್ಟ–ತಿಪ್ಪಗೊಂಡನಹಳ್ಳಿ ಜಲಾಶಯದಿಂದ ಮಂಚನಬೆಲೆ, ರಾಮನಗರ, ಕನಕಪುರ, ಸಂಗಮದವರೆಗೆ ಹೊಳೆಯನ್ನು ಅನುಸರಿಸಿ ಹೋದಾಗ, ಎಲ್ಲ ಭಾವನೆ, ಕನಸುಗಳಿಗೆ ವ್ಯತಿರಿಕ್ತವಾದ ಚಿತ್ರಣ ಕಣ್ಣಮುಂದೆ ಬಂದಿತ್ತು. ಅರ್ಕಾವತಿ ನದಿಯ ಸ್ವರೂಪವನ್ನೇ ಕೆಡೆಸುವಂತಹ ಕೃತ್ಯ ಹೊಳೆಯ ಸುತ್ತಮುತ್ತ ನಡೆದಿದೆ.

ಅರ್ಕಾವತಿ ನದಿ ಎಂದ ಕೂಡಲೇ ಇಂತಹ ನದಿ ಇದೆಯೇ? ಅದರಲ್ಲೂ ಬೆಂಗಳೂರಿನಲ್ಲಿ ಇದೆಯೇ? ಎಂಬುದು ರಾಜಧಾನಿ ಬೆಂಗಳೂರಿನಲ್ಲಿ ವಾಸಿಸುತ್ತಿರುವ ಬಹುತೇಕರ ಪ್ರಶ್ನೆ. ಅವರಿಗೆಲ್ಲ ಅರ್ಕಾವತಿಯ ಉಪನದಿಯಾದ ವೃಷಭಾವತಿ ಗೊತ್ತು. ಏಕೆಂದರೆ, ರಸ್ತೆಯಲ್ಲಿ ಸಾಗುವಾಗ ಅಲ್ಲಿನ ನೈರ್ಮಲ್ಯ ಮೂಗು ತುಂಬುತ್ತದೆ. ಆದರೆ, ರಾಷ್ಟ್ರೀಯ ಹೆದ್ದಾರಿಯಲ್ಲಿ ಹಾದುಹೋಗುವ ಹೆಸರಘಟ್ಟ ಹಾಗೂ ತಿಪ್ಪಗೊಂಡನಹಳ್ಳಿ ಜಲಾಶಯಗಳಿಗೆ ಆಧಾರವಾಗಿರುವ ಅರ್ಕಾವತಿ ಬಗ್ಗೆ ಹಲವರಿಗೆ ಗೊತ್ತೇ ಇಲ್ಲ. ಇದರ ಬಗ್ಗೆ ಹಲವು ಜನಪ್ರತಿನಿಧಿಗಳಲ್ಲೂ ಮಾಹಿತಿ ಇಲ್ಲದಿರುವುದು ವಿಪರ್ಯಾಸ. ಇಂತಹ ಪರಿಸ್ಥಿತಿಯಲ್ಲೂ ಕೆಲವು ಶಾಸಕರು ಇದೀಗ ಅರ್ಕಾವತಿ ನದಿ ಪುನಶ್ಚೇತನಕ್ಕೆ ಮುಂದಾಗಿರುವುದು ಸಂತಸಕರ.

ಅರ್ಕಾವತಿ ನದಿ ಹರಿವಿಗೆ ಕೆರೆಗಳೇ ಜೀವಾಳ. ನಂದಿಬೆಟ್ಟ, ಚನ್ನಗಿರಿ, ಹುಲುಕುಡಿ ಬೆಟ್ಟಗಳಲ್ಲಿ ಐದು ಮೂಲಗಳನ್ನು ಹೊಂದಿರುವ ಅರ್ಕಾವತಿ, ಬೆಂಗಳೂರು ಗ್ರಾಮಾಂತರ, ನಗರ ಹಾಗೂ ರಾಮನಗರ ಜಿಲ್ಲೆಗಳಲ್ಲಿ ಹರಿಯುತ್ತಾಳೆ. ಬೆಂಗಳೂರು ಗ್ರಾಮಾಂತರ ಜಿಲ್ಲೆಯಲ್ಲಿರುವ ಕೆರೆಗಳೇ ಅರ್ಕಾವತಿಗೆ ಆಧಾರ. ಅದರಲ್ಲೂ ದೊಡ್ಡಬಳ್ಳಾಪುರ ಹಾಗೂ ನೆಲಮಂಗಲ ತಾಲೂಕಿನ ಕೆರೆಗಳು ತುಂಬಿದರೆ ಮಾತ್ರ ಅರ್ಕಾವತಿ ಹರಿವು ಸಾಧ್ಯ. ಪ್ರಥಮವಾಗಿ ದೊಡ್ಡಬಳ್ಳಾಪುರ ತಾಲೂಕಿನಲ್ಲೇ ಅರ್ಕಾವತಿ ನದಿಗೆ ದುರ್ಗತಿ. ದೊಡ್ಡಬಳ್ಳಾಪುರ ತಾಲೂಕಿನಲ್ಲಿ ಸುಮಾರು 106 ದೊಡ್ಡ ಕೆರೆಗಳಿವೆ. ಆದರೆ ಒಂದೂ ಸುಸ್ಥಿತಿಯಲ್ಲಿಲ್ಲದಿರುವುದು ಅರ್ಕಾವತಿ ದುಸ್ಥಿತಿಗೆ ಹಿಡಿದ ಕನ್ನಡಿ. ದೊಡ್ಡಬಳ್ಳಾಪುರದಲ್ಲಿ ಅರ್ಕಾವತಿ ಕ್ಷೇತ್ರವೂ ಇದೆ. ಆದರೆ, ಈ ಹೊಳೆಯಲ್ಲಿ ನೀರು ಹರಿದು ವರುಷಗಳು ಕಳೆದಿವೆ. ಅಲ್ಲದೆ, ನಂದಿಯಿಂದ ಹರಿಯುವ ಅರ್ಕಾವತಿಗೆ ಪ್ರಮುಖ ತಾಣವಾದ ದೊಡ್ಡಬಳ್ಳಾಪುರದ ಕೇಂದ್ರ ಭಾಗದಲ್ಲಿರುವ ನಾಗರ ಕೆರೆ ತ್ಯಾಜ್ಯದ ಹೊಂಡವಾಗಿದೆ. ಒತ್ತುವರಿಯ ಆರ್ಭಟ ಮುಂದುವರಿದಿದೆ. ಇತಿಹಾಸ ಪ್ರಸಿದ್ಧ ಕೆರೆಗಳನ್ನೂ ನುಂಗಿಹಾಕುವ ಪ್ರಯತ್ನ ನಡೆಯುತ್ತಿದೆ.

ಅರ್ಕಾವತಿ ನದಿಪಾತ್ರದಲ್ಲಿ ಪ್ರಮುಖವಾದ ಸಮಸ್ಯೆ ಎಂದರೆ ಕಾಲುವೆಗಳು. ನಂದಿಬೆಟ್ಟದ ತಪ್ಪಲಿನಿಂದಲೇ ಹೊಳೆ ಅಥವಾ ಕಾಲುವೆಗಳಿಗೆ ತಡೆ ಆರಂಭವಾಗುತ್ತದೆ. ಬೆಟ್ಟದಿಂದ ಇಳಿಯುವ ನೀರು ಪ್ರಥಮ ಸರಣಿಯ ಕೆರೆಗಳು ತುಂಬಿಸಿದರೂ, ಅಲ್ಲಿಂದ ಮುಂದಕ್ಕೆ ನೀರು ಹರಿಯುವುದು ಕಷ್ಟಕರ. ಏಕೆಂದರೆ, ಹೆಗ್ಗಡಿಹಳ್ಳಿ, ಕಣಿವೆಪುರ, ನಂದಿಗುಂದ್ಯ, ಮೇಳೆಕೆರೆಗಳಿಂದ ಕಾಲುವೆಗಳು ವ್ಯವಸ್ಥಿತವಾಗಿಲ್ಲ. ಇನ್ನು ಮುಂದಿನ ಕೆರೆಗಳ ಕಾಲುವೆಗಳಂತೂ ಮೈದಾನದ ಮಟ್ಟಕ್ಕೆ ಏರಿ ನಿಂತಿವೆ. ಕಾಲುವೆ ತಡೆ ನಿವಾರಣೆ, ಒತ್ತುವರಿ ತೆರವು ಸೇರಿದಂತೆ, ಕಾಲುವೆಗಳನ್ನು ಉತ್ತಮ ಮಟ್ಟದಲ್ಲಿ ಉಳಿಸಿಕೊಳ್ಳಬೇಕು. ಜತೆಗೆ ಕ್ವಾರಿ, ಫಿಲ್ಟರ್ ಮರಳಿಗೆ ತಡೆ ಹಾಕಬೇಕು.

ದೊಡ್ಡಬಳ್ಳಾಪುರ, ನೆಲಮಂಗಲ, ಯಲಹಂಕ, ದಾಸರಹಳ್ಳಿ, ಯಶವಂತಪುರ ವಿಧಾನಸಭೆ ಕ್ಷೇತ್ರಗಳ ಶಾಸಕರು ಅರ್ಕಾವತಿ ನದಿ ಪುನಶ್ಚೇತನದಲ್ಲಿ ಪ್ರಮುಖ ಪಾತ್ರ ವಹಿಸುತ್ತಾರೆ. ಏಕೆಂದರೆ, ಈ ಐದು ವಿಧಾನಸಭೆ ಕ್ಷೇತ್ರದಲ್ಲೇ ಅರ್ಕಾವತಿ ಆರಂಭಿಕ ಹಂತದಲ್ಲಿ ಹರಿಯುವುದು. ಇಲ್ಲಿ ಕೆರೆಗಳ ವ್ಯಾಪ್ತಿ, ಕಾಲುವೆಗಳಲ್ಲಿರುವ ತಡೆಯನ್ನು ನಿವಾರಿಸಬೇಕು. ಕೆರೆಯಲ್ಲಿ ಮಣ್ಣು ತೆಗೆಯುವುದು, ಇಟ್ಟಿಗೆಗೂಡಿ ಇಡುವುದು ಹಾಗೂ ಫಿಲ್ಟರ್ ಮರಳಿನ ದಂಧೆಯನ್ನು ನಿಲ್ಲಿಸಬೇಕು. ಇದಾದ ನಂತರ, ಮಾಗಡಿ, ರಾಮನಗರ, ಕನಕಪುರ ಕ್ಷೇತ್ರದ ಶಾಸಕರು ಹೊಳೆಯಲ್ಲಿ ಹರಿಯುತ್ತಿರುವ ನೀರಿನ ಮಾಲಿನ್ಯಕ್ಕೆ ತಡೆ, ಫಿಲ್ಟರ್ ಮರಳಿಗೆ ಮಣ್ಣು ತೆಗೆಯುವುದಕ್ಕೆ ನಿರ್ಬಂಧಕ್ಕೆ ಪ್ರಮುಖವಾಗಿ ಗಮನಹರಿಸಬೇಕು.

ಅರ್ಕಾವತಿ ನದಿಯನ್ನು ಹರಿಸಬೇಕೆಂಬ ಯೋಜನೆಗೆ ರಾಜಕೀಯ ಇಚ್ಛಾಶಕ್ತಿಯೇ ಪ್ರಬಲ ಅಸ್ತ್ರ. ಸ್ಥಳೀಯ ಶಾಸಕರು ತಮ್ಮ ಕ್ಷೇತ್ರದಲ್ಲಿ ಹರಿಯುವ ಅರ್ಕಾವತಿಗೆ ಯಾವುದೇ ಪ್ರಭಾವಕ್ಕೆ ಒಳಗಾಗದೆ ರಹದಾರಿ ಮಾಡಿಕೊಡುತ್ತೇವೆ ಎಂಬ ನಿಲುವು ಹೊಂದಿದ್ದೇ ಆದರೆ, ಹೊಳೆ ನಿರಾಂತಕವಾಗಿ ಹರಿಯುತ್ತದೆ. ಮಳೆ ಕಡಿಮೆ ಎಂಬ ಸಾಮಾನ್ಯ ಕಾರಣ ನೀಡುವ ಬದಲು, ಕಾಲುವೆಗಳು ಮುಚ್ಚಿಕೊಂಡಿರುವುದರಿಂದ ಕೆರೆ–ಹೊಳೆಗೆ ನೀರು ಹರಿಯದೆ, ನೀರು ಪೋಲಾಗುತ್ತಿರುವುದನ್ನು ಪ್ರಥಮವಾಗಿ ತಡೆಗಟ್ಟಬೇಕು. ಕಾಲುವೆಗಳಲ್ಲಿ ನೀರು ಸರಾಗವಾಗಿ ಹರಿಯುವಂತೆ ಮಾಡಿದರೆ, ಅರ್ಕಾವತಿ ಪುನಶ್ಚೇತದ ಅರ್ಧ ಕೆಲಸ ಮುಗಿದಂತೆ.

ಇದರ ಜತೆಗೆ ಪ್ರಮುಖವಾಗಿ ಅರ್ಕಾವತಿ ನದಿ ಪುನಶ್ಚೇತನಕ್ಕೊಂದು ಪ್ರಾಧಿಕಾರ ಅಥವಾ ಸಮಿತಿಯ ಅಗತ್ಯವಿದೆ. ನದಿ ಪುನಶ್ಚೇತನಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಎಲ್ಲ ಇಲಾಖೆಯ ಅಧಿಕಾರಿಗಳು, ನದಿಪಾತ್ರದ ಶಾಸಕರು, ಪರಿಸರ ತಜ್ಞರು ಈ ಸಮಿತಿಯಲ್ಲಿರಬೇಕು. ನದಿ ಪುನಶ್ಚೇತನಕ್ಕೆ ಸಕ್ರಿಯವಾಗಿ ತೊಡಗಿರುವ ಎನ್‌ಜಿಒಗಳಿಂದ ಸಲಹೆದಾಯಕ ವರದಿಗಳನ್ನು ಪಡೆದುಕೊಳ್ಳಬೇಕು. ಪುನಶ್ಚೇತನ ಕಾರ್ಯದಲ್ಲಿ ಇಲಾಖೆಯಿಂದ ಇಲಾಖೆಗೆ ಅಲೆಯುವ ಬದಲು, ಅರ್ಕಾನದಿ ಪುನಶ್ಚೇತನ ಪ್ರಾಧಿಕಾರ ಅಥವಾ ಸಮಿತಿಗೆ ನದಿ ಪಾತ್ರದಲ್ಲಿ ಎಲ್ಲ ರೀತಿಯ ಕ್ರಮಗಳನ್ನು ತೆಗೆದುಕೊಳ್ಳಲು ಸಂಪೂರ್ಣ ಅಧಿಕಾರ ಇರಬೇಕು.

ARKAVATHY INFORMATION REPOSITORY – A MEANS TOWARDS MANAGING WATER RESOURCES

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THE SITUATION

Phenomenal growth of the Bangalore city as a result of rapid industrialization, economic activities and the consequent demographic expansion has brought in considerable pressure on the water resources in the region in general and on the Arkavathy river in particular. Though ambiguous, it is true, absence of innovative approaches in planning in Thippagondanahalli Reservoir catchment of Bangalore Metropolitan Region has lead the developmental activities that have created more disorder in the system, than allowing sustainable use of its natural resources. The studies carried out have indicated that the Arkavathy catchment has the potential to provide necessary services to the human enterprise, if proper strategies are adopted for sustainable use and abuse of the system.

Water, by its mere existence does not represent a resource. It becomes one, when it is easily accessible and available at a place where it is needed in the quantity and quality required. The aspects related to water becoming a resource need to be understood, described and presented to its stakeholders. It is the stakeholders who determine the health of the system also one of the system components. The water in the Arkavathy river catchment has conflicting stakeholders as follows:

- About 1.5 million (approx.) urbanites looking for quenching their dinking and other domestic needs,
- Almost one million of the rural community, along with their livestock looking for irrigational as well as drinking requirements.
- Huge industrial estates looking for processed water as well drinking supplies

For every requirement mentioned above, the administration has built apparatus such as huge number of minor irrigation tanks, reservoirs like Hesarghatta and the TGR for urban water supply and Manchanbele reservoir for irrigation. Besides these, large number of (may be more than few thousands) borewells have been sucking water from the subsurface for both drinking and irrigational needs across the catchment. In addition to the natural input i.e., the rainfall that builds the potential of water resource in the catchment, there has been an imported component also. Few hundred MLD of Cauvery water is being let in to catchment after use for various purposes.

THE REQUIREMENT

It has been a fact that the all the reservoirs in the Arkavathy catchment do not receive designed inflows and as consequence reduced storage of water. Further, it is also the apprehension that flow duration as well as the volume in the river course has reduced and the river many not be helpful anymore. At certain places the pollution menace has posed threat to the very use of even groundwater. The diagnostic appraisal and analysis of the system carried out earlier by ISRO/IN-RIMT has been able to bring out the problems developed due to the absence of proper management and has been able to help identification of programs of action. It is apparent that the entire society including men-women, landless labourers, farmers, researchers and the policy makers and above all, system managers – the institutional personnel should act to improve the situation. It is necessary that emphasis on two important issues can help to create and support the emerging new professionalism of water resources management. They are as follows:

1. Setting up an Information Repository – both spatial and non-spatial obtained from methodological research to bridge gap between subjects including main river and its tributaries, the system of tanks and reservoirs, communications and
2. Dissemination of the information, monitoring and training which stresses field work and learning from farmers.

New professionalism means looking at the system in its entirity – the stakeholders (people –urban and rural, farmers) and orientation towards optimal utilization of the resources and apart from the mere engineering projects of construction but also operation. Research mentioned here pertains to the learning and linking process where in the results obtained through improved and latest techniques/methods need to be correlated with problems manifested and attempts to establish links between results and system elements, so that a compromising, amicable methodology develops in the process.

ARKAVATHY INFORMATION REPOSITORY

Up-to-date spatial information about the Arkavathy catchment is essential for effecting a better water management because it facilitates comparative as well as realistic analysis of the conditions prevailing in the catchment. The location of each stream, tank and other details like the design discharge of each of these are important inputs. Also, the land use pattern, extent of the area under different crops is crucial for understanding the water requirement at discrete level. Further, information on rainfall, its distribution across the catchment, runoff potential at micro-watershed level, water quality variation, depth to water table, other infrastructure, socio-economic aspects become handy for devising better management procedures. These are to be organized

around a Geographical Information System (GIS), a better facility for analysis and decision. Therefore, looking into the existing procedure of data/information management, it is suggested to develop a strong spatial information system for the Arkavathy catchment and make it accessible to the stakeholders.

Arkavathy Information Repository (AIR) will be the core engine and beginning of the process of rejuvenation of the river. It is essentially a spatial as well as attribute database engine with a capability of analysing and acting as a decision support system. It provides inputs to and receives feedback and facilitates development of management plans. The performance monitoring and analysis should be the built-in facility of repository. It should be a customised geographical information system (GIS) having a reliable database support. Following information should be the input to the AIR that needs to be updated as and when there are changes:

- Drainage network – detail information on river, trunk stream and other streamlets, tanks and the command served by each tank
- Information on climatic as well as daily rainfall (humidity, temperature, evaporation/ evapo-transpiration etc.).Rainfall variation information – derived map of rainfall distribution and updated on regular basis and runoff potential at each micro-watershed
- Land parcels information - the individual survey numbers in the villages and cropping pattern
- Spatial information on location of borewells (borewell census), average extraction of groundwater, groundwater quality and depth to water table.
- Information on soils at parcel level, regarding its fertility, permeability and irrigability.
- Information on general infrastructure (transportation network, communication linkages, power supply etc.) and market, trade and commerce.
- Village level up-to date socio-economic information.
- Information about the reservoir storage and inflow into the reservoir

Since the envisaged AIR is a computer based information system, a mechanism has to be there for feeding the desired information into the system which calls for setting up multi-disciplinary team of professionals. Once the desired data sets are integrated in the system, with iterative trials, a decision support system could be developed and customised. The role of AIR in water resources management is not only to facilitate better management decision and procedures, but also to act as an "**on line information system"** to the farmers of the entire command and to the policy makers also. Therefore, a facility for processing and updating the value added information from the remote sensing satellites has to be integrated to it. The main station of AIR may set up at a convenient location and information be centrally updated and should be available over

internet to others. The proposed repository envisages maintaining a reliable spatial database on the river catchment. Generating, collecting, collating and organising the spatial information are only one time affair. Any changes in due courses could be detected easily as the mechanism proposes adoption of remote sensing techniques for spatial data capturing and processing.

INTEGRATED APPROACH AND SPEEDY LAWS ARE NEEDED TO REJUVENATE ARKAVATHY

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Introduction -dependence on Arkavathy Water for Bangalore

Bangalore City and Arkavathy River, an important Tributary of Cauvery River remained inseparably linked till a few decades back, as the city's one third of water supples were met by this tributary through its Reservoir at Thippagondanahalli. Even now, when the River is dying, when catchment area has been abused with harmful effluents from various sources,and when the riverbeds have been snatched and usurped for urbanization, that link of potable water supply of water for the growing population of the city cannot be severed. On how many more Phases of Cauvery Water Supply can we depend for meeting the demands of water at huge costs and perhaps, at the risk of turning Cauvery itself into a Dry River Bed in 3 to 4 decades!

The 1st Phase, 4th Stage of Cauvery was executed at Rs 1072 crores and the 2nd Phase incurred Rs 3383 crores.It is an irony that we are forced to bring Cauvery Water from a long distance and lift it to a great height to deliver it to residents of the CITY here.Imagine another scenario of getting water by linking rivers or from desalinization plants at a future date!

Some successes

When we kill our own resources of water and neglect our watersheds and catchment areas, we would be forced to face hardships further such as we have never heard of earlier. Therefore, our Tributary Arkavathy needs to be once again harnessed to the brim and rejuvenated to yield potable water as of the past, though the hurdles are many and the cost very high. Is it possible when vested interests dominate the show and not allow any pragmatic solution to be pursued ?. Considering the urgent necessity to improve water supplies to Bangalore City,many efforts were made in the past by the Government through its Departments and Authorities and by a number of NGOs.Some were successful while others were unsuccessful to achieve goals of sustainable supply and distribution systems. Their efforts were isolated in addressing the problem in multi-dimensional ways including enforcing stringent laws for encroachment of lands, unauthorized constructions, disrupting of the free flow of the river or stream in the watershed.

The ecology and well being of the Water and the Catchment area could, perhaps, been taken care of though many solutions. Urbanization, industrialization and agriculture have left their tell tale marks of pollution. However, all these earlier efforts have created not only awareness among the public but also attracted NGOs to study the issues in some specific directions. An integrated approach of planning, investment and participation from Government, NGOs and the people is needed to execute and monitor the the River and the Watershed as a whole.

River and WATER BODIES and Land Surfaces in the Watershed

Integrated approach demands monitoring of

(1) the River and Water bodies of small streams, tanks, wells and drainage/effluent flows; and

(2) the Land surfaces including farm lands,hill-tops of the Watersheds. small industries, and houses, slums with scant arrangement for waste disposal and

Unfortunately no separate identification and protection is seen in the two above aspects. Considerable efforts are required to prevent inlets of the effluents and drainage channels into water bodies like streams and tanks. They should be at safe distance away from rivers, streams and tanks. With two to three heavy rains in the peak of monsoons, there could admixture of all these along with the muddy waters from excess runoff from fields. Village and town planning officials should look into these aspects of management and of sanitation and health of the people.The river and streams banks should be planted with trees on both the sides along the flow of water. Grass-cover should be maintained at near the trees to avoid the eroded soil to get dropped into the stream.The tank bunds should be functional with sufficient height, waste weirs and with grass slips planted and replanted when required. A row of trees around would be highly beneficial. No washings of animals, vehicles and bathing of people be allowed. Silt needs to be removed every year by peoples' participation.

Lakes or Tanks in the Watershed.

Great care was bestowed in maintaining the Tanks in yester-years around the period of our Independence. In Arkavathy watershed , perhaps there were over 3000 tanks but only 1250 tanks seem to be present now. Some were in cascading order with smaller tanks in upper reaches and big tanks at the lower heights. With sequence Currently the tanks are in a bad state. Besides loss of water storage from the reduction of the number tanks, most tanks have been silted reducing further the storage capacity.In recent years monsoons have not been steady and consequently the Arkavathy River went dry and so also some tanks. Under these circumstances, How can we rejuvenate the Arkavthy system with over draft of water for irrigation from the already depleted status from every angle? It is for these reasons we need to start afresh in planning to rejuvenate

water-bodies as well as in all spehres where water is being used in agriculture,industry and for drinking purpose for Bangalore City.

Can Greenery and Farming Revive the Catchment area and Save Arkavathy River?

In the Arkavathy basin as in most urbanized or industrialized catchment areas, there are green patches of untended trees and estates having some commercial crops besides some regular plots of small farmlands.

The pros & Cons of EUCALYPTUS

Although exact statistics are not available,some estimates indicate that Arkavathy watershed has more than 50 to 55 percent of Eucalyptus. It is so because of (a) lack of farm workers or labourers for raising Agricultural crops;

(b) dry land crops of ragi , sorghum, dolichos, cow pea etc., do not fetch adequate returns;

(c) Eucalyptus is best suited for as absentee land-lords while they can work in cities;

(d) They raise this crop as it provides high income after a few years required for the daughters wedding or to repay the loan raised for varied purposes.

Would strengthening Groves/Greenery or Cropping help the Watershed ?

The question that needs to be studied is “Whether free flow of water through stream or river is stopped by such green plots of partial farming or quadroned off with either an eucalyptus or a timber block?” Can they revive catchment area, collect and purify the rain water through litter-fall, make easy access to water to flow without being a blockade ? The answer is neither affirmative or negative in nature. If there are plenty of trees with good leaf litter, and if the bunds are protective, rainwater can infiltrate well into soil and if water flows out as surface run-off, it would let out good water without soil being eroded and thus making a muddy water to join the fresh water sources. If agricultural crops are raised in the small plots, the bunds have to be constructed well or else,when rains or flash floods occur, the surface run-off would take away with it the soil, fertilizers and pesticides. Surface run off can carry dissolved salts and fertilizers of nirogen and phosphorous leading to Eutropication of water bodies which receive these. Algal growth on the surface make such waters not usable as oxygen would be depleted. Further these toxic chemicals would affect the ground water. Pollution and its load would depend on what type of greenery is maintained in the farm land. If a forest or even a mini-forest is established in a series of farmlands or about 40 to 50 meters on both sides of the river which is flowing a distance of 190 km length, by clearing all

buildings, houses, industries etc., we may be taking the first step in rejuvenating the Arkavathy River.The situation is highly variable in the 26 Taluks coming under Arkavathy Basin.

Agriculture is also a source of Green House gases emissions: Rice production and livestock reaing would release Methane,it is indicated. Methane is more powerful by five-folds than CO2. The N2O emissions can occur from agricultural soils. All these agricultural activities may account for 9 perdcent of Green House Gas Emissions as per IPCL report. It is greenery in whatever form which could absorb carbon dioxide and release Oxygen.With only about 20 percent of forestry, Agro forestry can help a great deal in improving the situation in rejuvenating Arkavthy basin.

Mulberry crop, the most important commercial crop in Arkavathy Basin: One crop, the evergreen Mulberry, raised Kanakapura & a few taluks needs to be considered carefully. It is fed with the highest amount of fertilizer,in the range of 300 to 400kg per ha.of nitrogen but the crop utilizes only 100 to 120 kg nitrogen. What happens to the rest of this fertilizer ? A large quantity of this gets into ground water. The water quality in many places has been affected with nitrate content of above 50 mg per liter.When consumed over a period,it affects the health. the Blue baby syndrome is partly because of this due to disrupting the availability of oxygen in the blood of the infant. The nitrate gets converted into nitroso-amines and further can cause Cancer. Use of chopped straw can reduce the leachates of fertilizers.The pesticides used for this crop as well as some commercial crops can leave residues on the produce affecting the health of the consumes. The soil is also affected leading to bad quality of surface and ground waters.The bleaching powder or other chemicals used in sanitation of mulberry rearing rooms is dangerous in destroying ozone in the atmosphere. On the plus points, mulberry gives employment to many thousand families, provides good income and enriches the soil with lots of left overs of feed material which can be composted.

Silk Industry in the Arkavathy Basin: Doddaballapur Taluk at the North and Kanakapura Taluk at the South could be considered **two EPI-Centers of Volcanoes,as it were, but on a different plane of a Silk Industry and Mulberry Farming and Eucalyptus destroying the whole of Arkavathy River and Watershed Area of over 4350 sq km.**

Doddaballapur accommodates 50,000 Power-looms to manufacture silk fabric.The **80 and odd Dyeing Units produce around 2.5 lakh liters of toxic effluents per day.** Thus, this Garment Industry contaminates both Surface Waters and Ground water.The original availability of good water is lost on two counts—**1)**on diversion to industry and **2)** on contamination. May we also pause for a few seconds to imagine the plight of those hapless boys who have to get their hands scalded while taking out the boiled cocoons! Can we switch over to embroidered sarees rather than dyed ones to save water for

drinking ! Though the pollution caused has not been fully taken into cognizance in Arkavathy area, we have to remember the fate of life in what is known as “The Golden Corridor”, a strech of 500 km from Mumbai and Vadodra,where fabric -dyeing industry has no potable water. The animals and people are in deep trouble to get potable water.

Let us think and act to work against this type of degration.

SRI Paddy and some agronomic measures to save Water.

Paddy is a guzzler of water.Wastage is seen and felt but no concrete action is taken. A change in Rural Bangalore from puddled paddy to SRI method can save 30 lakh liters per acre.What a big saving if effectively implemented on at least 6000 ha in Bangalore Rural District.Even Zero Tillage is helpful to reduce water needs of crops. Saving in seeds and some inputs have reduced the cost of cultivation. Agronomic measures like paired system of planting the cereals and including suited pulses would not only save water but would also help reducing some inputs and improve total yields from the system.Aerobic rice can also be of specil interest.Aerobic method of composting as in Modified Japanese Method of Composting by Dr. K. Shivashankar has

These have to reach the watershed area of Arkavathy.

Horticultural crops.

If yields of dry and semi irrigated crops are enhanced with improved methods and individual farmers can divert an area of one third to two thirds of thier farm land to irrigated horticulture. The crops grown here are highly amenable for saving water. The average results from some studies with a comparison of Conventional Irrigation with Drip Irrigation indicate a saving of water by 30 to 40 percent and increase in yields by 25 to 40 percent with drip system or drip- fertigation as in experiments with 16 crops at UAS, Bangalore. Introduction of horticultural crops like Drumstick, Amla, Pomegranate, Jackfuit, Seethaphal, Guava, Lime, Wood apple etc., in alley cropping or as mini horticultural orchards can reduce the water buget with drip installations in the long run . Even Cites and towns also should have flowering trees. All these mesures help in taking care of Ecological equilibrium and rejuvenate the watershed.

Some urgent tasks are

Together with the Greening of the whole area,

Water bodies need urgent attention with no effluents and sewage to cross near streams and tanks should be protected with trees and grass cover;

Groundwater exploitation should be strictly avoided and water bugeting for agriculture be monitored;

Tanks should be rehabilitated and Rain Wate Harveting should be immediately initiated all over the watershed;

Water Quality be monitored,Avoid toxins like lead, NO_3 to reach surface or ground water.

Agricultural practices to be updated so to secure higher yields of cereals, pulses and oilseed crops and to intrduce Horticultural Crops in the same area to save water through drip systems.

WATER QUALITY STUDIES IN ARKAVATHI BASIN

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Abstract

Land use in geographic areas that replenish groundwater and surface water resources is increasingly recognized as an important factor affecting drinking water quality. Industrial and agricultural activities often impose significant pressures to the groundwater quality and consequently degrade wetland ecosystems that depend mostly on subsurface water flow. Efforts to understand the implications for health, particularly outcomes with long latency or critical exposure windows, have been hampered by lack of historical exposure data for unregulated pollutants. The present study has been conducted around Bangalore rural and Ramanagara district area, analysis reports shows that water samples have contaminated with fluoride and nitrate and high hardness content.

INTRODUCTION

Groundwater pollution is one of the most common environmental problems nowadays Leachates from landfills and uncontrolled industrial effluents disposal cause significant deterioration in the water quality of many aquifers throughout the world.

Groundwater is the source of drinking water for many people around the world, especially in rural areas. Groundwater can become contaminated naturally or because of numerous types of human activities. Residential, municipal, commercial, industrial, and agricultural activities can all affect groundwater quality (U.S. EPA, 1993). Contamination of groundwater can result in poor drinking water quality, loss of water supply, high clean-up costs, high costs for alternative water supplies, and/or potential health problems. A wide variety of materials have been identified as contaminants found in groundwater. These include synthetic organic chemicals, hydrocarbons, inorganic cations, inorganic anions, pathogens, and radionuclide.

STUDY AREA

Bangalore rural and Ramannagara district the analysis results of 40 groundwater samples are considered for this report. The nitrate content varies from 3.0 ppm to 325.00 ppm in Kodugurthy, Devanahalli taluk and Mathikere, Channapatna taluk locations respectively. There are 6 samples which is above the threshold value of 45 ppm in Kanakapura taluk; 3 samples in Channapatna taluk; one sample in Ramanagara taluk; 3 samples in Magadi taluk of Ramanagara district. One sample in Nelamangala taluk; 4 samples in Doddaballapura taluk; 2 samples in Devanahalli taluk and one sample in

Hoskote taluk of Bangalore Rural district. Iron is in excess of 0.3 ppm in one sample each in Channapatna taluk, Devanahalli taluk & Hoskote taluk respectively. Fluoride is in excess of 1.50 ppm in 3 samples from Ramanagara taluk. One samples each from Channapatna, Magadi and Kanakapura taluks. Fluoride is less than threshold limit in all the taluks of Bangalore Rural district. 5 samples analysed from Kanakapura, Ramanagara, Nelamangala taluks are above 600 ppm in respect of total hardness. Kanakapura town location the value is 1120 ppm. Many samples are in the range of 300 to 600 ppm indicating that it could utilized in the absence of alternate source in respect of total hardness in Kanakapura, Ramanagara, Channapatna, Magadi taluks mainly and very few samples from Doddaballapur, Devanahalli and Hoskote taluks. In general good is safe groundwater for all the above parameters are found in 3 samples from Kanakapura and Hoskote taluks; one each from Devanahalli, Doddaballapur, Magadi, Ramanagara, Channapatna and 2 samples from Magadi respectively.

In Doddaballapur taluk effluent samples was collected around Gogo exporters pvt ltd., and and Himshu Ltd factory and the samples were analysed. The analysis results showed the groundwater was contaminated due to effluent discharged by the factories. Cl-1323, No3-112, TDS-3750, pH-8.97, Zn-1.32, Al-35.28, COD-588, TH-1510 mg/L.

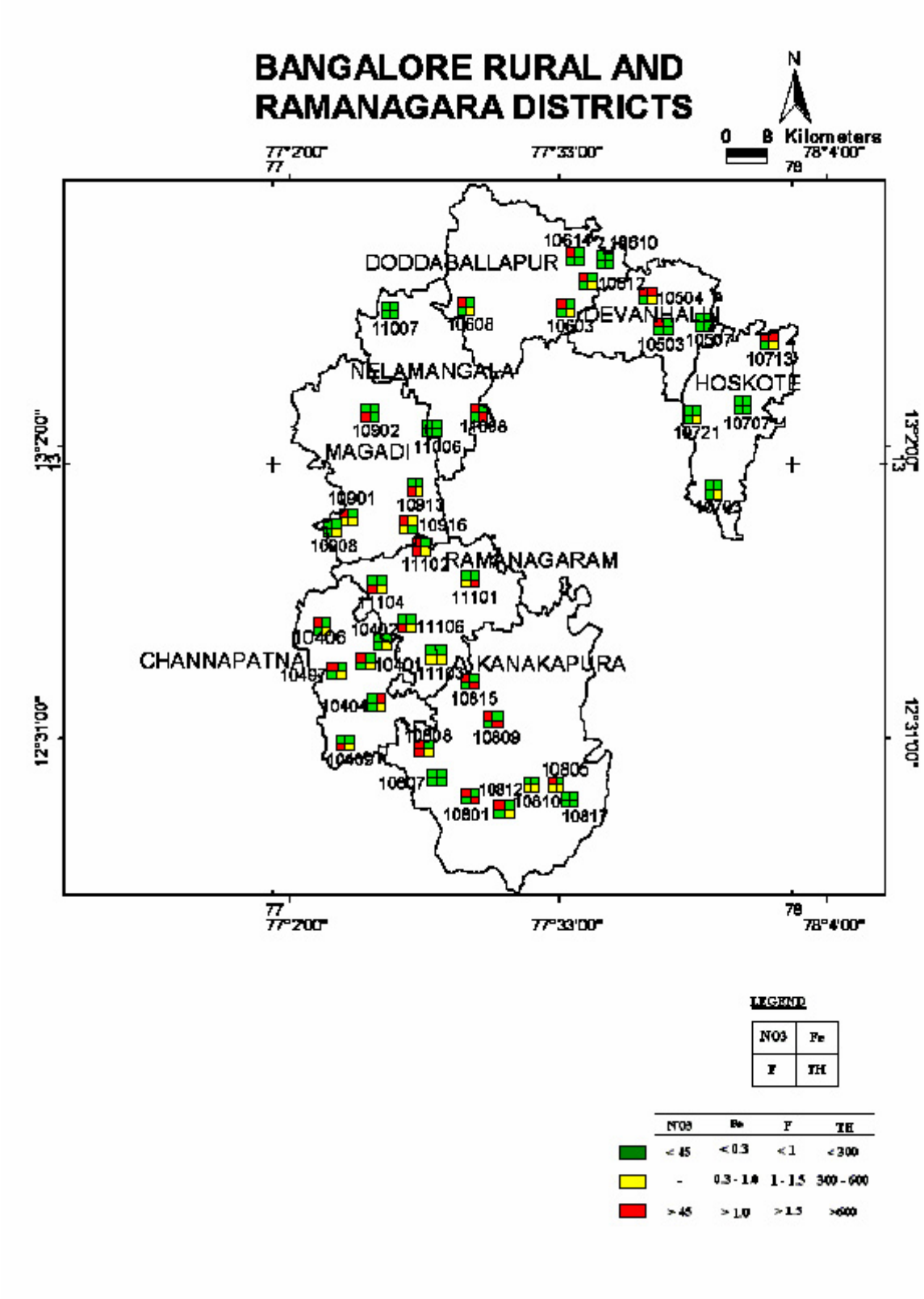
In Hebbugodi village, Bangalore south and Peenya the ground water was contaminated TH-4950, COD-422, NO3-126, Chromium in peenya 16.1 mg/L

MATERIALS AND METHODS

Water sample analysis was carried in by analytical method as per BIS standards. The results of the test are:

COMPREHENSIVE ANALYSIS DATA OF BANGALORE RURAL DISTRICT

Sl. No.	TALUKS	CONSTITUNETS IN mg/L		
		Nitrate	Fluoride	Total Hardness
		Per limit 45mg/l	Per limit 1.0-1.5	Per limit75-200mg/l
1.	Anekal	4-94	0.05-0.78	244-1580
2.	Bangalore North	7.3-153	0.1-0.4	228-528
3.	Bangalore South	20-176	0.05-0.65	252-608
4.	Channapatna	7-81	0.2-1.46	252-616
5.	Devanahalli	2.5-120	0.23-2.5	280-552
6.	Doddaballapura	1-168	0.2-0.75	184-624
7.	Hoskote	3.6-63	0.1-0.82	192-748
8.	Kanakapura	0.88-235	0.2-3.2	236-748
9.	Magadi	5-124	0.3-2.0	104-660
10.	Nelamangala	7-140	0.2-1.2	176-632
11.	Ramanagara	1-113	0.48-2.52	316-600


BANGALORE RURAL AND
RAMANAGARA DISTRICTS
N
0 8 Kilometers
77°20'00"
77
77°33'00"
78°4'00"
79
13°20'00"
13
12°31'00"
12
DODDABALLAPUR
DEVANHALLI
NELAMANGALA
HOSKOTE
MAGADI
RAMANAGARAM
CHANNAPATNA
KANAKAPURA
10614
10610
10612
10504
10503
10507
10713
11007
10608
10902
11006
10707
10721
10901
10913
10916
10908
11102
11101
1104
11106
10406
10402
10401
10497
10404
10815
10809
10808
10807
10806
10812
10610
10801
10817
LEGEND
NO3
Fe
F
TH
NO3
Fe
F
TH
< 45
< 0.3
< 1
< 300
-
0.3 - 1.0
1 - 1.5
300 - 600
> 45
> 1.0
> 1.5
>600

RESULTS AND DISCUSSION

There is an heavy contamination of flouirde,hardness,nitrate is observed in all District which is beyond permissible limits. Sources near Doddaballapur, Peenya are all affected due to industrial pollution. Doddaballapur is effected due to Gogo factory, Peenya is effected by chromium. Critical parameter effects on the human health beyond the permissible limits are given below:

Nitrate	>45 ppm - Leads to Methoemoglobinemia, Cancer
Fluoride	>1.5 ppm - Leads to Dental fluorosis, skeletal fluorosis
Total Hardness	>600 ppm - Effects on domestic use
Total Dissolved Solids	>2000 ppm - Causes gastro intestinal irritation
Total Iron	>1.0 ppm - Promotes iron bacteria

Regarding Industrial effluents, Industries can reuse and recycle the chemicals and. materials and switch to less toxic alternatives and advanced treatment methodologies Sewage water and waste have to be treated before disposal. Discharge of raw sewage waters will lead to bacterial contamination and depletion of dissolved oxygen which causes the eutrophication of water bodies which can be minimized by treating the waste water from the source itself. Apart from physiochemical test of samples one need to study the biological characteristics of waste water to determine the presence of pathogenic bacteria which affects the public health when it mixes with water.

INSTITUTIONAL AND LEGAL FRAMEWORK FOR PLANNING AND MANAGING RIVER BASINS

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Abstract

The Karnataka state water policy 2002 (http://waterresources.kar.nic.in/state_water_policy-2002.htm) recognizes the need for River Basin Institutions after making a startling admission on institutional arrangements and their lack of coherence and convergence 'There are no institutional arrangements at the State level to consider sectoral water, demands, plan and manage water between them. Responsibilities of water issues are fragmented between different departments without formal mechanism to ensure co-ordination.' (Item 5.1 of the Karnataka State Water Policy 2002).

In the future vision item 6.1 it goes on to state that 'Water resources planning, development and management will be carried out adopting an integrated approach for a hydrological unit such as River basin as a whole or for a sub basin, multi-sectorally, conjunctively for surface and ground water incorporating quantity, quality and environmental considerations. Development projects and investment proposal will be formulated and considered within the framework of river or sub-basin plan so that the best possible combination of options can be obtained for poverty alleviation, increasing incomes and productivity, equity, reduced vulnerability to natural and economic risks and costs. Solutions to water allocation and planning issues will be found adopting a demand management approach.'

Since that visioning statement precious little has been done to transform policy into action.

RIVER BASIN INSTITUTIONS

The nature of river basin institutions that are emerging in India follow the Maharashtra model or are created under judicial orders such as the Pampa River Basin Authority in the state of Kerala and the Ganga River Basin Authority. The Pampa River Basin Authority is very river specific and case specific relating to the pollution of the river due to the pilgrims attending the Sabarimala temple and the attendant pollution of the river from the waste stream. The National Ganga River Basin Authority with the Prime Minister of India in the chair has also been created under the Environment Protetcion Act 1986 with the specific purpose of coordinating the cleaning of the river and the prevention of its pollution. The functions of the National Ganga River Basin Authority are

Its functions will include:-

- Development of river basin management plan and regulation of activities aimed at the prevention, control and abatement of pollution in the river Ganga to maintain its water quality, and to take such other measures relevant to river ecology and management in the Ganga Basin States;
- Maintenance of minimum ecological flows in the river Ganga with the aim of ensuring water quality and environmentally sustainable development;
- Measures necessary for planning, financing and execution of programmes for abatement of pollution in the river Ganga including augmentation of sewerage infrastructure, catchment area treatment, protection of flood plains, creating public awareness and such other measures for promoting environmentally sustainable river conservation;
- Collection, analysis and dissemination of information relating to environmental pollution in the river Ganga;
- Investigations and research regarding problems of environmental pollution and conservation of the river Ganga;
- Creation of special purpose vehicles, as appropriate, for implementation of works vested with the Authority;
- Promotion of water conservation practices including recycling and reuse, rain water harvesting, and decentralised sewage treatment systems;
- Monitoring and review of the implementation of various programmes or activities taken up for prevention, control and abatement of pollution in the river Ganga; and
- Issuance of directions under section 5 of the Environment (Protection) Act, 1986 for the purpose of exercising and performing all or any of its functions.

Both these river basin authorities have been rather ad-hoc in their creation mostly led by judicial decisions.. A more systematic approach is that of the state of Maharashtra.

MAHARASTHRA EXPERIENCE

The state of Maharashtra has created the Water Resources Regulatory Authority with quasi-judicial powers over allocation of water between various sectors in the state. The MWRRA has gone on to create River Basin Authorities for each of the rivers in Maharashtra. This is a classic top down approach emulating the Electricity Regulatory Reforms and the creation of the State Electricity Regulatory Commissions – the ERC's- which also adopt a quasi-judicial regulatory approach.

The state of Karnataka would be better advised to adopt a more participatory approach as envisaged in its own water policy- The management of water resources shall be done adopting a participatory approach. Necessary legal and institutional

changes will be made. The ultimate goal will be to transfer operation, maintenance, management and collection of water charges to users groups.(Item 6.7 State water policy 2002)

At the apex could be the State Water Resources Board- For multi-sectoral water planning, inter sectoral water allocation, planning of water development programmes, management decisions, and resolution of water resources issues, a State Water Resources Board will be established. The Water Resources Development Organization will act, as technical secretariat for the State Water Resources Board. A State Water Resources Data and Information Center will also be established.(Item 6.3 State Water Policy)

Each of the 7 River systems in the state could then have a River Basin Institution comprising professionals, stakeholders and elected representative in equal numbers .These Institutions (and not Authorities) would essentially be a planning and designing institutions collating and compiling information dynamically, arriving at water allocation decisions, drafting plans of actions through the Gram Panchayats/urban local self governments and the various line departments of the governments and also monitoring projects in a dynamic fashion. Sub – basin institutions could also follow these river basin institutions.

The primary goal of such institutions would be to translate the policy and the priorities identified in the State water Policy to ‘on ground’ implementation. Primary objective would be to ensure water for life and livelihoods and for food and nutrition security. Ecological flows in rivers and water for the environment would be needed to be determined by these institutions as well as inter basin transfers if any in a full participatory and dialogue mode.

Implementation of the plans of the river basin institutions should primarily be the task of the urban local self governments and the rural Gram Panchayats. Here the Kerala experience will stand in good stead. Empowered Panchayats are included as part of the drinking water, water for agriculture and watershed activities with the bulk of the activities carried out by them. The challenging task would be to coordinate the major works of Watershed development, Jala Samvardhane Yojane, Minor and major irrigation projects, groundwater management and recharge schemes and urban and rural water supply schemes.

CONCLUSIONS

The state has tremendous experience and learnings of participatory water management, be it in the irrigation projects through the Participatory Irrigation management schemes, the Jala Samvardhane Yojana Schemes (Tank rehabilitation schemes), the Watershed Development schemes, the transfer of rural water supply and sanitation schemes to Gram Panchayats and the learnings thereof as well as the clear

constitutional identification under the 73rd and 74th Amendment of the Constitution of India under the 11th and 12 th schedule. The legal regulatory framework will need to build on the subsidiarity principle and recognize the right of the smallest unit of governance the gram panchayat and the urban local self governments as the best units of legal management in a rights based framework. Including local self governments and building capacities will be the right way of managing the often difficult task of the layering of administrative boundaries over watershed and hydro-geological boundaries.

The other often difficult task of hydro electric power generation and the requirement of water for thermal and nuclear power plants, which is a state level issue as opposed to being a local issue, will need to be addressed by the river basin institutions too. The broader level allocations of water use by the state will all come from the various tribunals in place but managing local allocations, ensuring local participation will all be the responsibility of River Basin Institutions . In an era of climate change and huge demand on the natural resource that is water, in an era of dying rivers and polluted rivers, in an era of depleting groundwater and frequent droughts and floods – a necessary response is the creation of responsible and democratic river basin institutions within states to manage our water resources in a participatory, democratic yet technically and financially sustainable fashion.

REQUIEM FOR OUR RIVERS

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PRICE OF DEVELOPMENT

Copious flows in the Arkavathi is a thing of the past

This is a requiem for the Arkavathi and most of our peninsular rivers. The Arkavathi is a tributary of the Cauvery. Rising in the Nandi Hills to the north of Bangalore it passes through most of Bangalore Rural district and joins the Cauvery at Sangama in Kanakapura district. It flows for 190 kilometres and in hydrological parlance is called a second order stream, meaning it is a tributary of the Cauvery which joins the sea. The Cauvery is a first order stream flowing into the sea, its major tributaries are second order streams and the Vrishbhavathi which joins the Arkavathi is a third order stream. The catchment area from where the water collects in the river is more than 4000 square kilometres. Yet the Arkavathi is dead and barely flows during heavy rains. Why is that so? This is a sorry tale of the death of a river.

When Bangalore first ran out of water from within its boundaries in 1894 it was decided that a reservoir at Arkavathi would need to be built to ensure that enough water was available to the city. The Hessarghatta reservoir, about 24 km from the city, was built on the Arkavathi and continued to supply water till about 1934 when the second reservoir on the Arkavathi called the Thippagondanahalli or the Chamaraja Sagara Reservoir was constructed to bring in more water for the increasing thirst of Bangalore.

Both reservoirs were built on the Arkavathi for The Gazetteer of Bangalore Rural says the Arkavathi "is not exactly a seasonal stream, in the summer months it presents the usual aspect of a sandy bed with a small current of water flowing at one side." In short it was a perennial river. Large tanks such as the Madhure and the Dodballapur ere also constructed on the river and would usually fill up. The town of Dodballapur depended on the Arkavathi for its drinking water requirement as did the town of Ramanagara.

Groundwater was available at 1 to 3 metres below ground level in the Arkavathi basin. Wells ranging from 2 to 10 metres in diameter and depths of between 3 to 12 metres provided up to 60,000 litres of water per day. In summer, well water would fall at best to 4 metres. Wells provided drinking water for all villages as well as agricultural water for irrigation. More than 30,000 wells were present in the Arkavathi basin. This was the situation till the 1980s.

PRESSURE

What killed the Arkavathi? A combination of the natural phenomena of drought and pressure on the catchment of the river. From 1980 to 1987, six out of the eight years were drought years with below normal rainfall. Wells dried up and were replaced by deep tubewells and borewells. Over-pumping resulted in a steep fall in the water table with most wells drying up and a competitive deeper drilling of borewells resulting in depths of nearly 300 metres being reached. With the fall in the groundwater table there was no base flow into the river. It first dried up in summer but then was unable to flow in the rainy season except for a few days. The tanks and the channels leading to the tanks were encroached upon or mismanaged and the links of surface water flows to the river stopped. All the tanks dried up and the Hessarghatta was abandoned as a reliable source of water to the city. The same fate awaits the Thippagondanahalli in a few years when it too will cease to be a reliable source for storage. The Nagarakere or the Dodballapur tank was long since given up as a source and the drinking water situation there is perilous with most water coming from private tankers. Villages struggle for drinking water in the basin especially in summer as borewells go dry.

The change of land use to predominantly agricultural activities resulted in the levelling of land and the construction of field bunds. Ploughing of land was a natural corollary to farming activities. Runoff from the land became zero. Sand mining and granite quarrying disrupted rivers badly and added to the problem.

Then came the industries with their huge water demand. The apparel park set up in Dodballapur in the Arkavathi basin will need water from the Cauvery and so will the international airport in the Dakshina Pinakini basin. The second order streams are dead and the first order Cauvery is the only reliable source. The question is for how long?

What does it mean for property? In the absence of any river basin- level institution even at the second order stream level, who will be responsible for the planning of the rivers and waters both above the ground and below the ground? Who will plan, invest and manage the waters of our rivers and who will be held accountable for failures?

With the coming up of the international airport a property boom is on in Dodballapur. Land prices have skyrocketed and housing colonies, resorts, restaurants and apartments are seeking to locate themselves there. But where is the water for this development?

Unless we create the right institutions at the right river basin level and arm them with the ability to plan and act on the plan, water shortages will be the order of the day and will hinder livelihoods and economic growth. Agencies such as the Bangalore Water Supply and Sewerage Board are woefully inadequate to manage sources and to provide water for all.

This is true of ALL our second order streams and it is a matter of time that climate change hits us and starts affecting first order rivers.

Water wisdom lies in recognising problems at the scales at which they occur and taking remedial action at that scale legally, institutionally and financially so that the problems are overcome.

Economic development and poverty reduction will be hit unless ecological resources are taken care of and that is the responsibility of ALL of us as citizens of the country. Recognise the river basin you are in and take action to revive it.

Water wisdom is leaving things better for the future generations than what we inherited.

THE ROLE OF COMPUTERS IN THE DEVELOPMENT OF DODDAMUDUWADI MICRO WATER SHED, KANAKAPURA TALUK, RAMANAGARA DISTRICT

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SACRED Trust, Doddamudawadi village
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SACRED Trust (Sahajananda Computer-aided Rural Education and Development Trust), an NGO, has its presence in the villages covered under Doddamuduwadi Micro Water Shed. Prof.Lingaraju of the Global Academy of Technology, Bangalore, has defined the boundaries of the DMWadi microwatershed. The SACRED Trust has been imparting computer education to the rural students in 9 villages witthin the limits of the DMWadi microwatershed. These villages are Gollahalli, Kadasikoppa, Pichanakere, Dodda Kalbal, Chikka Kalbal, Kotgal, Angarahalli, Doddamuduwadi and Bandiganahalli. The two tributaries of Arkavati river namely, Vrishabhavati and Suwarnamukhi come together in the northern part of the microwatershed and flow due south to join the Arkavati.

Agriculture within the DMWadi microwatershed is dependent on rainfall which is scanty being in the range of 600.mm to 750.mm. The microwatershed is bordered on the west by a chain of prominent hills of granites, 950m to 850m high, spread in N-S direction over a length of 10 km. A chain of natural lakes dot the valley region to the east of the granite hill range. Thus, the granite hills serve as catchment for these lakes.

Over 2000 farmers belonging to Doddamuduwadi, Kotgal and Pichankere villages have been dreaming since over 4 decades to make their livelihood better if ever the filtered waters of the Vrishabhavati and Suvarnamukhi are pumped into the Kotgal lake which is the northern most of the chain of lakes flowing towards Doddamuduwadi. The farmers have addressed many representations to their elected representatives, yet their dream has remained unfulfilled.

Recently a group of students from the GAT under the guidance of Dr. Lingaraju and assistance of the SACRED Trust undertook a study of water quality of the lakes and borewells dotting the microwatershed. During the course of these studies some of the local farmers pleaded with the SACRED Trust and Prof. Lingaraju to support their demand for making the Kotgal-Muduwadi lakes perennial by linking them with the filtered waters of the Vrishabhavati.

It is in the aforesaid connection that we, in the SACRED Trust, have thought about educating the local students, youth and the farmers with the knowledge of their microwatershed by utilizing the computers already established by the SACRED Trust in these villages. *"Fruits of economic development fall where educated people live"*.

Hence, if we want to enrich villages, we should transform a village into a knowledge society and also induce the educated to live in villages. Computers are a way to decent living in village India. We propose to store the computers with all the detailed data and maps of the microwatershed, besides information about the possibility of pumping filtered waters of the Vrishabhavati into the rain-dependent lakes. And, there will also be Topographic maps and Digital Elevation Models showing locations of rainwater harvesting structures that could be built to dam the rain waters flowing eastward down the chain of granite hills into the lakes. The information so stored would be used as platform for discussion among the farmers to elicit their input based on their native wisdom and, if necessary, to modify the proposed plans and locations of rainwater harvesting structures.

Indian Government plans to spend about Rs.40,000 crore on IT in coming years. One of the initiatives would be the establishment of the "Unique Identification Authority of India (UIDAI)" which will be headed by Infosys Co-Founder Mr.Nandan Nilekani. The SACRED Trust believes that the computer-educated farmers and their grown up children, living within the limits of the microwatershed, when armed with their *Unique Ids*, could make their voice and demands heard more effectively to draw the attention of the concerned authorities and elected representatives to make their living conditions much better than at the moment.

RESTORATION OF LAKES IN BRUHUTH BANGALORE MAHANAGAR PALIKE

Satish
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INTRODUCTION

- Bangalore enjoys a salubrious climate
- Industrial and IT hub
- India's fifth largest city
- Astronomical growth in the past decade
- Traffic congestion
- Unplanned growth
- Degradation of lakes

MAJOR WATERSHEDS IN BANGALORE

- Hebbal Drainage system
- Koramangala Drainage system
- Challaghatta Drainage system
- Vrishabhavathi Drainage system

STATUS OF LAKES IN BANGALORE CITY

- 262 numbers recorded in 1961
- City experience astronomical growth in the past two decades.
- Rapid urbanization resulted in change in land use pattern in catchments and command area.
- Almost all city lakes ceased to function for the purpose they were built
- Many lakes have been breached and converted into land for other purpose
- There are about 150 in lakes remaining in BBMP area.

MAJOR SOURCES OF POLLUTION TO CITY LAKES

- Entry of Sewage and Industrial effluent through storm water drains
- Dumping of Solid waste

IMPACT ON LAKES DUE TO POLLUTION

- Quality of water impaired considerably resulting into eutrophication condition
- Reduction in flora and fauna
- Siltation and reduction in volume
- Loss of aesthetic value
- Increased in mosquito menace

- Encroachment by land sharks, place for illegal activities, unplanned growth in the periphery of lake

PLAN TO RESTORE BANGALORE LAKES

- Government of Karnataka taken series of actions to protect urban/city lakes
- Lake Development Authority (LDA) established in 2002
- Lakshaman Rao Committee instituted to examine condition of lakes and suggest remedies
- Ramswamy committee constituted to study encroachment
- Government Orders issued to protect city/urban lakes
- Forest Department was given the task of protecting lakes
- BBMP, BDA, FD and other Urban Local bodies are involved in restoration of lakes

LAKES ALREADY RESTORED IN BANGALORE CITY

BBMP

1. Sankey tank
2. Tavarekere
3. Ulsoor lake
4. Yadiyur lake
5. Kempambudhi
6. Byrasandra

INEP

1. Hebbal
2. Madivala
3. Doddabommasandra

Forest Departmemt

1. Hennur
2. Vasanthapura
3. Kengeri
4. Challakere
5. Narasipura 1
6. Narasipura 2
7. Akshaya Nagar
8. Doddakallasandra
9. Deepanjali Nagar kere
10. Malagai
11. Halegarbarahalli
12. Doddabommasandra-Kodigehalli

Lake Developmewnt Authority

1. Vengaihnakere
2. Jaraganahalli-Sarakki
3. Nagavara

Bangalore Development Agency

1. Agaram
2. Benniganahalli
3. Lalbagh

BBMP PLAN FOR RESTORATION OF LAKES

- 21 lakes taken up for rejuvenation/ restoration
- Revenue survey completed in respect of 17 lakes
- Encroachment removed in 2 lakes
- Fencing work in progress in 12 lakes
- DPRs prepared for 17 lakes
- Rejuvenation/restoration commenced with BBMP funds in 17 lakes
- Mini STPs will be installed at the outlets in few lakes

PHYSICO-CHEMICAL CONDITION OF LAKES

- pH value altered
- High BOD
- High COD
- Reduced / Nil DO
- Eutrophication
- Septic condition
- Excess Nitrogen, Phosphours in sediment
- Heavy metals in sediment

MITIGATION MEASURES SUGGESTED

- Diversion channel for carrying away dry-weather flow from the lake
- Mini STP at inlets to treat waste water
- Construction of engineering wet land for final treatment of waste water
- Bio remediation during O&M

LAKE IMPROVEMENT COMPONENTS

- De-weeding
- De-silt tank bed to improve capacity of water holding
- Improve/Strengthen tank bund and its appurtenances
- Fencing all round tank
- Joggers Path
- Island for supporting flora and fauna
- Separate Idol immersion tank
- Boat Jetty for navigation and recreation
- Children's Park
- Tree Plantation on Shore line
- Toilet for male and females inside park
- Shelters and Gazebos
- Green Parks
- Parking facility

PROJECT BENEFITS

- Fresh water body
- Urban Eco system developed
- Lung space
- Fresh air
- Recreation
- Flood control
- Groundwater recharge in the region
- Improvement in quality of groundwater