OPTIMISED MAINTENANCE DREDGING VOLUMES IN INLAND WATERWAYS

PROPOSED TECHNICAL WORKING GROUP

TERMS OF REFERENCE

1. Historical Background Definition of the Problem

Maintenance dredging is essential to preserve the navigability of inland waterways in many parts of the world. In major river systems, dredging is a recurring intervention required to maintain adequate depths for safe and reliable vessel operation, and it directly influences navigation performance, transport efficiency, maintenance planning, budgeting and investment decisions.

The estimation of dredging volumes is therefore a critical element of inland waterway management. These estimates are used to support feasibility studies, maintenance planning, cost forecasting, procurement strategies and long-term waterway management programmes. In most cases, dredging volumes are estimated by comparing existing bathymetric conditions with a predefined navigation channel condition or target depth.

The methodological approach to dredging volume estimation depends strongly on the nature of the waterway under consideration. Three main typologies can be distinguished: (I) natural free-flowing rivers, where hydro morphological dynamics dominate and the stability of the fairway is a central concern; (ii) regulated rivers, where human control of hydrology and morphology reduces variability but maintenance dredging remains necessary at specific reaches; and (iii) canals, where cross-sections and hydraulic regimes are largely engineered and sedimentation patterns are generally more predictable. The parameters, data requirements and methodological choices for estimating dredging volumes differ accordingly across these typologies, and this distinction will be explicitly considered throughout the work of this Working Group.

In practice, many dredging volume estimates are still based on deterministic approaches using a single hydrological reference condition, one bathymetric surface and fixed channel dimensions. While such approaches are widely used, they do not always represent the variability of hydrological conditions, channel morphology or operational reliability requirements in a sufficiently robust and transparent way. This challenge becomes even more relevant under increasing hydrological variability and changing river regimes observed in many inland waterway systems.

A clear methodological gap therefore exists. There is a need for practical guidance to improve the robustness, consistency and transparency of dredging volume estimates, to reduce their sensitivity to arbitrary assumptions, and to support more reliable planning of maintenance dredging interventions.

2. Objectives

The objective of this WG is to develop an internationally applicable methodological framework to improve and optimise the methods used for estimating maintenance dredging volumes in inland waterways, considering the different typologies of waterways (natural free-flowing rivers, regulated rivers and canals).

The specific objectives of the WG are to:

- review current international practices used for estimating maintenance dredging volumes in inland waterways;
- assess the sensitivity of dredging volume estimates to key methodological parameters, including hydrological reference levels, bathymetric processing methods, sediment transport characterisation and operational navigation criteria;
- analyse the influence of hydrological variability, data availability and monitoring capacity and channel morphology on dredging volume estimation;
- investigate scenario-based and probabilistic approaches to improve the robustness of dredging volume estimates;
- identify practical methodological guidance for optimised estimation of maintenance dredging volumes in inland waterways, differentiated, where appropriate, by waterway typology.

The following topics are outside the scope of this WG: dredging methods or equipment, dredging execution techniques, environmental management of dredged sediments, disposal or beneficial use of dredged material, detailed sediment transport modelling, or geometric design of navigation channels. The focus of this work will be limited to the development of methodological guidelines aimed at improving dredging volume estimates used in the planning and management of inland waterways. The WG nonetheless recognises the strong interface between dredging volume estimation and the environmental management of dredged sediments; these aspects are addressed in complementary PIANC Working Groups, notably EnviCom WG 227 on risk-based environmental windows and EnviCom WG 109 on long-term management of confined disposal facilities for dredged material.

3. Earlier Reports to be Reviewed

- PIANC EnviCom WG 227 – *A guide for a risk-based approach to environmental windows for dredging and navigation infrastructure works*
- PIANC InCom WG 236 – *Sustainable Management of the Navigability of Natural Rivers*
- PIANC EnviCom WG 178 – Climate Change Adaptation Planning for Ports and Inland Waterways
- PIANC EnviCom WG 176 – *Working with Nature*
- PIANC InCom WG 141 – *Design Guidelines for Inland Waterway Dimensions*
- PIANC EnviCom WG 109 – *Long-Term Management of Confined Disposal Facilities for Dredged Material*

4. Scope of Work

The WG will investigate, compare and develop approaches for optimising the estimation of maintenance dredging volumes in inland waterways, with explicit consideration of the different waterway typologies (natural free-flowing rivers, regulated rivers and canals). The work will include a review of current methodologies used in different inland waterway contexts and an assessment of the main factors influencing dredging volume estimates, with the objective of identifying opportunities for methodological improvement.

The identification of methods for optimising dredging volume estimation is explicitly included within the scope of this WG. This optimisation may include the definition of more consistent methodological criteria, the incorporation of sensitivity analyses, the use of scenario-based approaches, and the assessment of probabilistic methods capable of representing hydrological variability and other relevant sources of uncertainty more appropriately.

Where appropriate, the WG will make use of representative international case studies to illustrate the application of the methodologies reviewed and to demonstrate how different assumptions and methods may influence dredging volume estimates under different inland waterway conditions.

Proposed steps

- Review current international practices for estimating maintenance dredging volumes in inland waterways.
- Identify the main methodological parameters influencing dredging volume estimates.
- Assess the sensitivity of dredging volume estimates to hydrological, morphological, sediment transport, bathymetric and operational assumptions.
- Evaluate different bathymetric processing and volumetric calculation methods.
- Investigate scenario-based and probabilistic approaches for improved dredging volume estimation.
- Analyse, where data are available, sediment fluxes and sediment budget approaches as a complementary basis for volume estimation and for the validation of morphodynamics and sediment transport models.
- Compile and analyse representative international case studies.
- Identify a methodological framework for optimised dredging volume estimation.
- Prepare the final report with practical guidance and recommendations.

5. Intended Product

The WG will produce a PIANC technical report providing practical guidance on improved and optimised methods for estimating maintenance dredging volumes in inland waterways. To make the outputs of the WG operationally useful to practitioners, the final report will include the following explicit deliverables:

(i) a recommended methodological workflow for dredging volume estimation, differentiated by waterway typology;

(ii) guidance on the design and interpretation of sensitivity analyses applied to the main methodological parameters (hydrological reference levels, bathymetric processing, morphological assumptions, sediment fluxes and operational navigation criteria);

(iii) decision-support criteria to identify when deterministic, scenario-based or probabilistic approaches are most appropriate, as a function of data availability, hydrological variability and the level of reliability required for maintenance planning.

The report is intended to support maintenance dredging planning, improve comparability between studies, reduce uncertainty in dredging volume estimates, and contribute to more consistent decision-making in inland waterway management.

6. Working Group Membership

The WG should include

- specialists with experience in inland navigation, river engineering, hydrology, fluvial morphology, hydrographic surveying, bathymetric data processing and maintenance dredging planning.
- members from both InCom, Marcom and EnviCom,
- members from different regions of the world and particularly Africa, South America and South Asia, will be desirable to ensure that the methodologies reviewed, and the recommendations proposed are internationally applicable and reflect different hydrological regimes, morphological settings and institutional practices.
- representatives from waterway authorities, research institutions, universities, specialised consultancies, dredging companies, and other organisations with relevant experience in inland waterway management and maintenance planning.

Where appropriate, the WG may seek contributions from external experts and relevant organisations (IAHR colleagues) with specific expertise in areas such as hydrology for navigation, river morphodynamics, hydrographic data analysis, uncertainty assessment, probabilistic methods and representative case studies.

7. Target Audience

The report will be intended for professionals and organisations involved in the planning, management, maintenance and development of inland waterways. It should be written in technical language appropriate for engineers, planners, managers and specialists responsible for navigability studies, dredging volume estimation, hydrographic surveys and maintenance planning in inland waterway systems.
The report should also be useful to public authorities, consultants, dredging companies, researchers, universities and international organisations involved in the development of methodologies and guidance related to inland waterway planning and management.

8. Relevance

8.1. Relevance to Countries in Transition, etc.

The WG236 report noted that the major free-flowing rivers of Africa and South America are characterized by high-dynamic hydrological variations, which necessitate specific recommendations. So, the report may be particularly useful for countries in transition, developing countries and similar contexts where resources available for inland waterway maintenance are limited and where more consistent dredging volume estimates can improve planning, prioritisation of interventions and allocation of funds. Improved methodological guidance may also support feasibility studies, maintenance programmes and decision-making in inland waterway systems with different levels of data availability and technical capacity.

8.2. Climate Change and Adaptation

This topic is relevant to climate change adaptation, since hydrological variability is one of the main factors influencing dredging volume estimates in inland waterways.

8.3. Working with Nature

The report is relevant from a Working with Nature perspective, as improved dredging volume estimation methods can contribute to a more consistent understanding of how hydrological and morphological processes influence the need for dredging interventions.

8.4. UN Sustainable Development Goals

This report may contribute to the following United Nations Sustainable Development Goals:

- Goal 9 – Industry, Innovation and Infrastructure
- Goal 11 – Sustainable Cities and Communities
- Goal 13 – Climate Action
- Goal 14 – Life Below Water

9. References

- U.S. Army Corps of Engineers (2015). *EM 1110-2-5025 – Dredging and Dredged Material Management*.
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- Ang, A.H-S.; Tang, W.H. (2007). *Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*.