Management of Rivers for an Environmentally Friendly Inland Waterway Transport System

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INLAND Waterway Transportation System (IWTS) is one of the modes of transport. Generally, waterways are categorised into natural and artificial. Rivers and lakes exist naturally as the result of geographically terrain while canals are artificial waterways created by man.

An inland waterway transportation system comprises facilities such as locks, inland port, weir, dock, navigation aids and bridges to facilitate navigation of vessels. Studies show that IWTS has advantages over other modes of transport. Studies also show that IWTS is the cheapest and least demanding on land acquisition, energy, labour, resources and mostly environmental benefits [1].

The philosophy of management has changed significantly, adapting to the environment. The management of water resource for transportation is a process of planning and controlling the resource in order that it can serve the purpose. The use of natural water resource for IWTS will change the physical characteristic and natural behaviour of the rivers. Furthermore, development of rivers for transportation will also change the economic value of the rivers as well. A well-designed IWTS requires an understanding of the problem, assembly and evaluation of all pertinent facts and development of a rational plan [2].

The main objective of waterway management is to maintain and protect the waterway environment. Good management practices should be able to provide an efficient and cost effective inland waterway transportation system, which is competitive with other modes of transport. In order to manage the inland waterway transportation system effectively, all criteria (water quality, safety standards and soil erosion) must be taken into consideration.

1.0 DEFINITION AND CLASSIFICATION OF IWTS

There are several definitions of inland waterway transport system. One common one used for the compilation of relevant statistics is from The Department of Transport (DOT) of the UK [3] and is as follows:

An inland waterway is deemed to include all water areas available for navigation that lie inland of the "inland waterway boundary". This boundary will correspond to the seaward point of any estuary, which it would be reasonable to bridge or tunnel. Inspection of UK estuaries leads us to conclude that this is where the width of water surface area is both less than 3 km at low water and less than 5 km at high water (springs). However, vessels without load lines are legally allowed to trade anywhere within the Partially Smooth Water Area (PSWA). The summer boundaries of PSWA are often far downstream of the inland waterway boundaries. The area between these two boundaries is defined here as "sheltered water". In the UK for example, the waterway classification system specifically designed for the survey of the official waterborne freight statistic classified into several categories (Table 1).

Table 1: Waterways classification in UK

Class	Specifications
A	9.0m plus draught
B	4.5m - 8.9m draught
C	3.0m - 4.4m draught
D	Less than 3m draught, barges 551 - 850 tonnes
E	Less than 3m draught, barges 351 - 550 tonnes
F	Less than 3m draught, barges 151 - 350 tonnes
G	Less than 3m draught, barges 51 - 150 tonnes

Source: DOT [3]

2.0 ROLE OF RIVERS

People used rivers as a natural mode of transport in the past when roads and rails were not well developed. Later, river transport faced competition from other modes of transport. Despite their fast speed and flexibility, however, other modes of transport contributed significantly to both congestion and environmental damage owing to their explosive and, even now, unchecked growth. Hence, these have become relatively uneconomic.

There is a growing awareness that rivers has a great potential as an alternative mode of transport to the existing road and rail networks. In difficult terrain that has substantial river networks, the option offers real economic development potential as conventional transport systems are currently unavailable. In general, the role of rivers can be broadly categorised as follows:

i. Leisure and Recreation

These include boating, boat building and services, pleasure cruising, angling, swimming, water-skiing, camping, etc.

ii. Water Supply and Water Transfer

Rivers provide water for industrial, domestic and agricultural which is drawn from surplus areas to water deficiency areas.

iii. Drainage

Rivers remove surplus rain or other water, conveying it to a large body of water where it can be safely absorbed i.e. flood control.

iv. Hydro-electricity

To generate electric power supply to consumers.

v. Transportation

Rivers can be used for transportation for both people and cargo.

3.0 INLAND WATERWAYS AND THE ENVIRONMENT

Efficient freight transportation systems can play a positive role in the economics of a country as well the quality of life of its population. While these are essential, there is growing concern over their significant negative environmental impact including pre-emption of land, disruption of topography, use of energy and resources as well as noise and air pollution [4].

Commercial transportation, which depends largely on fuel, contributes significantly to pollution levels. Therefore, we should think of the management of both the availability of energy resources and the environment before making a balanced decision about each transport mode.

Unlike other modes of transport, however, inland waterways can contribute a number of advantages to the enhancement or improvement of the environment [5]. Waterway transport is environmentally less harmful than other modes of transport in terms of noise and pollution. It is also cheap. In addition, inland waterway transport offers direct environmental benefits compared to other means of transportation.

i. Noise and Vibration

Unlike river transportation, the main contributors to transport noise are road, air and rail transportation [6]. In general, traffic noise is mainly felt in the urban areas.

ii. Visual Intrusion

Waterways cause little in the way of visual intrusion. In fact, they can even enhance the appearance of an area.

iii. Pollution

Waterway vessels do pollute the rivers to some extent. However, most water pollution comes from the irresponsible acts of industries located along the waterway.

iv. Atmospheric Emissions

Transport emissions in the UK produced 57% of nitrogen oxide, 91% of carbon monoxide and 42% of volatile organic compound [7]. A study carried out in the Netherlands in 1980 shows the levels of air emission from different modes of transport [8] (see Table 2).

4.0 PARAMETERS OF RIVER MANAGEMENT ON ENVIRONMENT

Management of rivers for sustainable inland waterway transport requires consideration on related issues as discussed in the following sections.

5.0 MANAGEMENT OF ENVIRONMENT QUALITY

It can be expected that the development of a waterway system for transportation will have some effect on the environment. Poorly planned and badly managed waterways are not only a threat to the safety of the vessels, users and freight but also to the environment. Thus, IWTS management system on water quality is among the major aspects to be considered. The standard of clean water is based on parameters such as pH (alkalinity and acidity), turbidity, BOD (biochemical oxygen demand), COD (chemical oxygen demand), TOC (total organic carbon) and TOD (total oxygen demand), heavy metals and inorganic solids.

Transportation activities along waterways will invariably affect the water quality. Vessel discharges, spills and grounding can result in minor damage to shellfish farms and even cause beaches to close. [10]. To maintain adequate depth of waterways, dredging will cause the degrading or pollution of water. In particular, dredging with open water discharge will activate dormant organic matter and increase turbidity and BOD.

The most appropriate measures in water quality control are the elimination of direct sources of pollution. Waste from boat operations and maintenance include pollutants such as petrol, oil, grease, solid waste, trash, lead, copper and detergent [11]. Increased pollutant loadings may result from facility construction, vessel discharges and accidental spills [12]. Other wastewater emanates from four primary sources as follow [13]:

i. Municipal sewage
ii. Industrial wastewaters
iii. Agricultural runoff
iv. Storm-water and urban runoff

Management of boat sanitary waste discharges includes the installation and proper use of equipment onboard the vessels and onshore equipment for collection and disposal [11]. Another effective mean of managing boat sanitary

Table 2: Emission levels from different modes of transport

Pollution type	Emission levels per tonne-km		
	Road	Rail	Inland waterways
Carbon monoxide	6.10	0.18	0.11
Hydrocarbons	1.15	0.06	0.07
Nitric oxide	3.05	0.89	0.69
Sulphur dioxide	0.15	1.09	0.10

waste discharges would be to educate boaters about the potential health risks associated with the discharge of sewage. Table 3 shows the processes applicable to wastewater treatment.

Table 3: Processes applicable to wastewater treatment

Pollutant	Processes
Biodegradable organics (BOD)	Aerobic biological (activated sludge), aerated lagoons, trickling filters, stabilisation basins, anaerobic biological (lagoons, anaerobic contact), deep-well disposal
Suspended solids (SS)	Sedimentation, floetation, screening
Refractory organics (COD, TOC)	Carbon adsorption, deep-well disposal
Nitrogen	Maturation ponds, ammonia stripping, nitrification, ion exchange
Phosphorus	Lime precipitation; Al or Fe precipitation, biological co precipitation, ion exchange
Heavy metals	Ion exchange, chemical precipitation
Dissolved inorganic solids	Ion exchange, reverse osmosis, electro dialysis

Source: [14]

6.0 SEDIMENT MANAGEMENT

Utilisation of water resource for transportation is highly dependent upon the maintenance of adequate navigation depth. Dredging is one of the methods of maintaining adequate navigation depth. In future, as ships increase in size and numbers on waterways, dredging will play a vital role in maintaining adequate depth in waterways. The volume of dredge materials will increase as well. The disposal of dredged material is usually the major problem faced by waterways management for transportation. Overall, proper sediment management will reduce the frequency of, if not eliminate, dredging work.

Reducing the amount of sediment entering the waterway will mean less need for frequent dredging. Besides carry out the dredging work to maintain adequate depth for passage of vessels, the management of waterways for transportation should, together other authorities involved in river basin management, also try to control the volume of sediment entering the rivers.

7.0 NATURAL HABITAT MANAGEMENT

Buffer zone protection will need a management programme to encourage the growth of native species and discourage invasive non-native species. Environmentalists and botanists strongly advocate an active programme to control non-native plant species and to support existing wildlife populations. As the first step in developing and implementing a management plan, nature conservancy programmes should make an assessment of non-native plants. The plan should call for the elimination of non-native species and the replanting of native stock as well as monitoring this on a long-term basis.

The goals should include restoring marginally productive agricultural lands into natural habitats, ripping up pavements in areas that won't contribute substantially to the local economy and restoring the natural habitat, protecting headwaters on both the main stem and tributaries and ensuring continuous natural vegetation along at least one bank for as much as possible of the river corridor proper.

8.0 DISCUSSIONS

Many inland waterways around the world have proved profitable and there exists a strong commercial reason for keeping them open as well as for further improvement and new development. Where similar conditions exist - in terms of geography, demand and potential development of trade, environmental enhancement, etc. – the opportunity for a new waterway development should take into consideration the proper management of the environment.

Inland transport provides cheap and efficient haulage. A combination of inland, estuary and coastal waterways can provide transportation at minimal costs. Local planning authorities should encourage the use of water transportation by investing in its improvement into a more efficient and economic system. The demand for inland water transport has risen steadily and this trend is likely to continue.

9.0 CONCLUSION

The development of a waterway system for transportation requires a wide range of knowledge, from the early stages of planning to full operations. Every development project should include stringent environmental impact assessment prior to actual development.

The economic benefits derived from the development of rivers for transportation must be in balance with the environment. The successful development of inland waterways for transportation requires the participation of various parties such as government agencies, private corporations and the public. ■