3rd European STAMP Workshop, STAMP EU 2015

Towards eSTAMP based dynamic safety management of eco-socio-technical maritime transport system

Robert Aps[a], Mihhail Fetissov[a], Floris Goerlandt[b], John Helferich[c], Madli Kopti[a], Pentti Kujala[b]

[a]University of Tartu, Estonian Marine Institute, Maealuse 14, 12618 Tallinn, Estonia

[b]Aalto University, School of Engineering, Department of Applied Mechanics, Marine Technology, Research Group on Maritime risk and Safety, P.O. Box 12200, FI00076 Aalto, Finland

[c] Massachusetts Institute of Technology, School of Engineering, 77 Massachusetts Avenue, Building 33-407, Cambridge, Massachusetts 02139-4307, USA

Hypothesis and objective

Hypothesis:

Systems Theoretic Accident Models and Processes (STAMP) can be extended beyond the area of socio-technical system safety into realm of complex eco-socio-technical systems safety (eSTAMP)

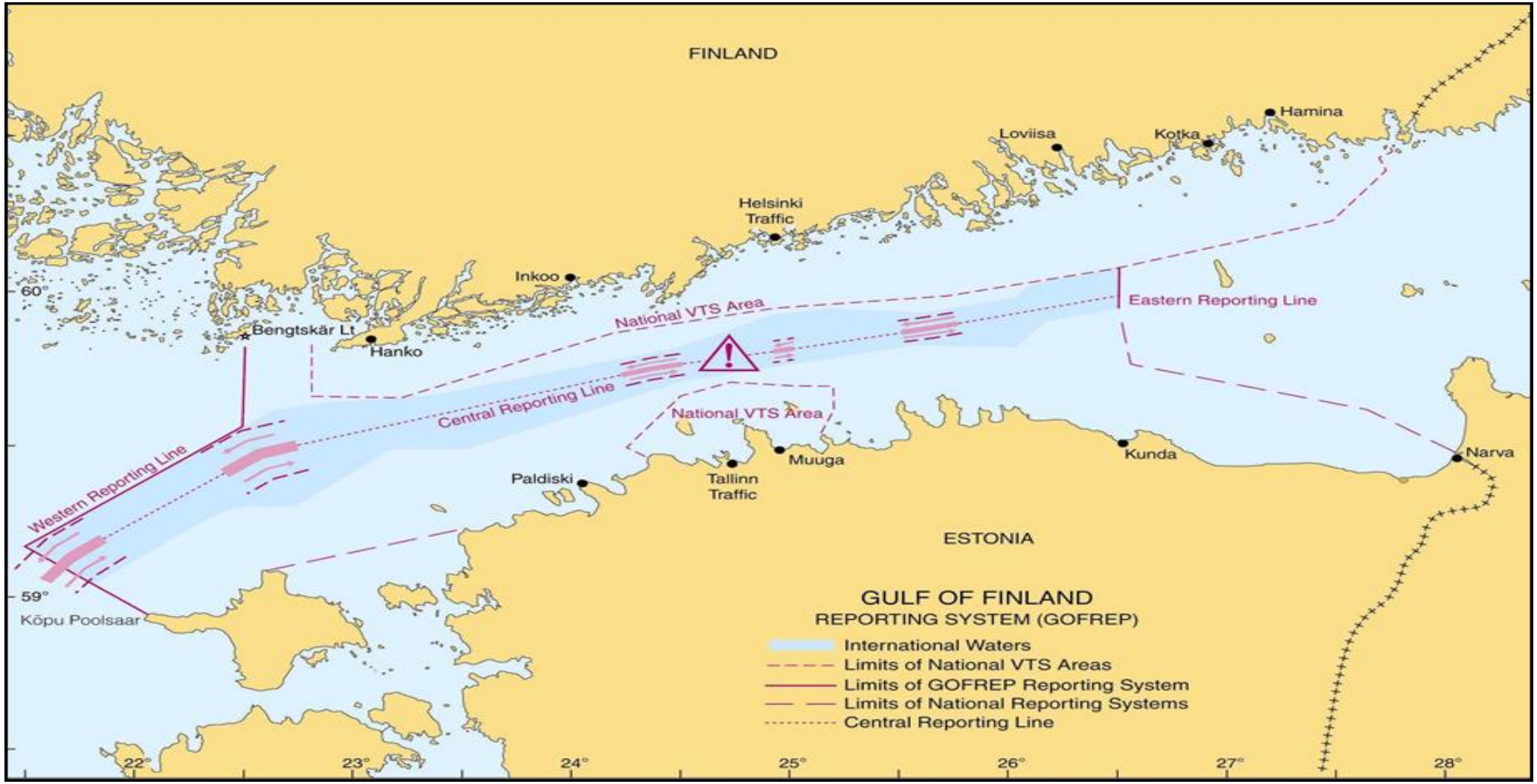
Objective:

Paper attempts to demonstrate the conceptual potential of eSTAMP based dynamic safety management of eco-socio-technical maritime transport system (GOFREP Case Study, the Gulf of Finland, Baltic Sea)

GOFREP Case Study

- **The Mandatory Ship Reporting System in the Gulf of Finland (GOFREP) covers the international waters in the Gulf of Finland.**
- **In addition, Estonia and Finland have implemented mandatory ship reporting systems to their national water areas outside Vessel Traffic Service (VTS) areas. These reporting systems provide same services and make same requirements to shipping as the system operating in the international waters.**
- **The mandatory ship reporting system and the Estonian and Finnish national mandatory ship reporting systems are together referred as the GOFREP and their area of coverage respectively as the GOFREP area.**

GOFREP Case Study geographical area



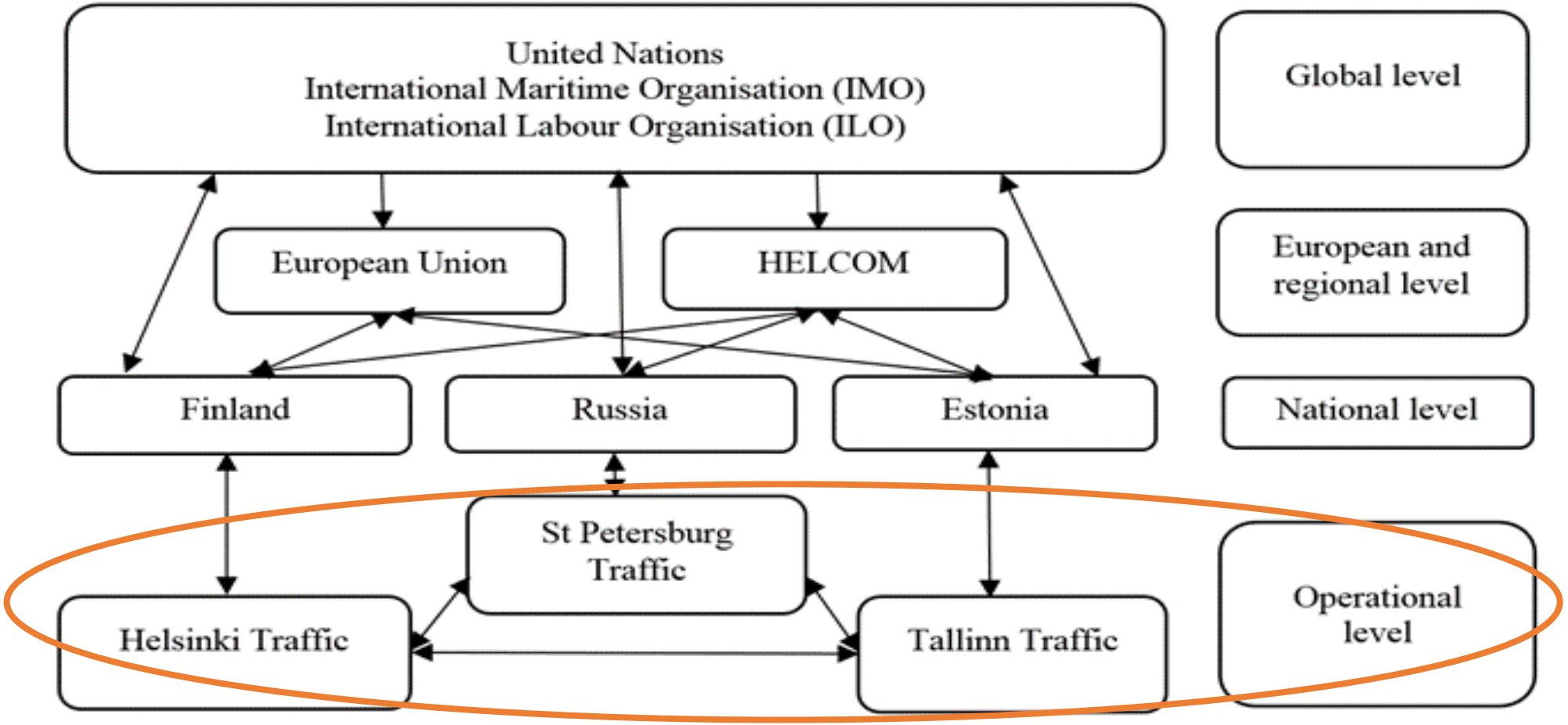
Source: Estonian Maritime Administration

GOFREP Case Study

- GOFREP is the maritime traffic control system jointly managed by Finnish Transport Agency, Estonian Maritime Administration and the Federal Agency for Maritime and River Transport of Russian Federation and is based on the activities of GOFREP Traffic Centres of Estonia (Tallinn Traffic), Finland (Helsinki Traffic) and the Russian Federation VTMIS Centre in Petrodvorets (Saint Petersburg Traffic).
- Each Authority provides information to shipping about specific and urgent situations which could cause conflicting traffic movements and other information concerning safety of navigation, for instance information about weather, ice, water level, navigational problems or other hazards.

STAMP – hierarchical levels of maritime traffic safety management and control in the Gulf of Finland, Baltic Sea including the GOFREP operational level (modified from Kuronen & Tapaninen, 2009)

◯ - the GOFREP level



GOFREP functions

The GOFREP functions are performed using

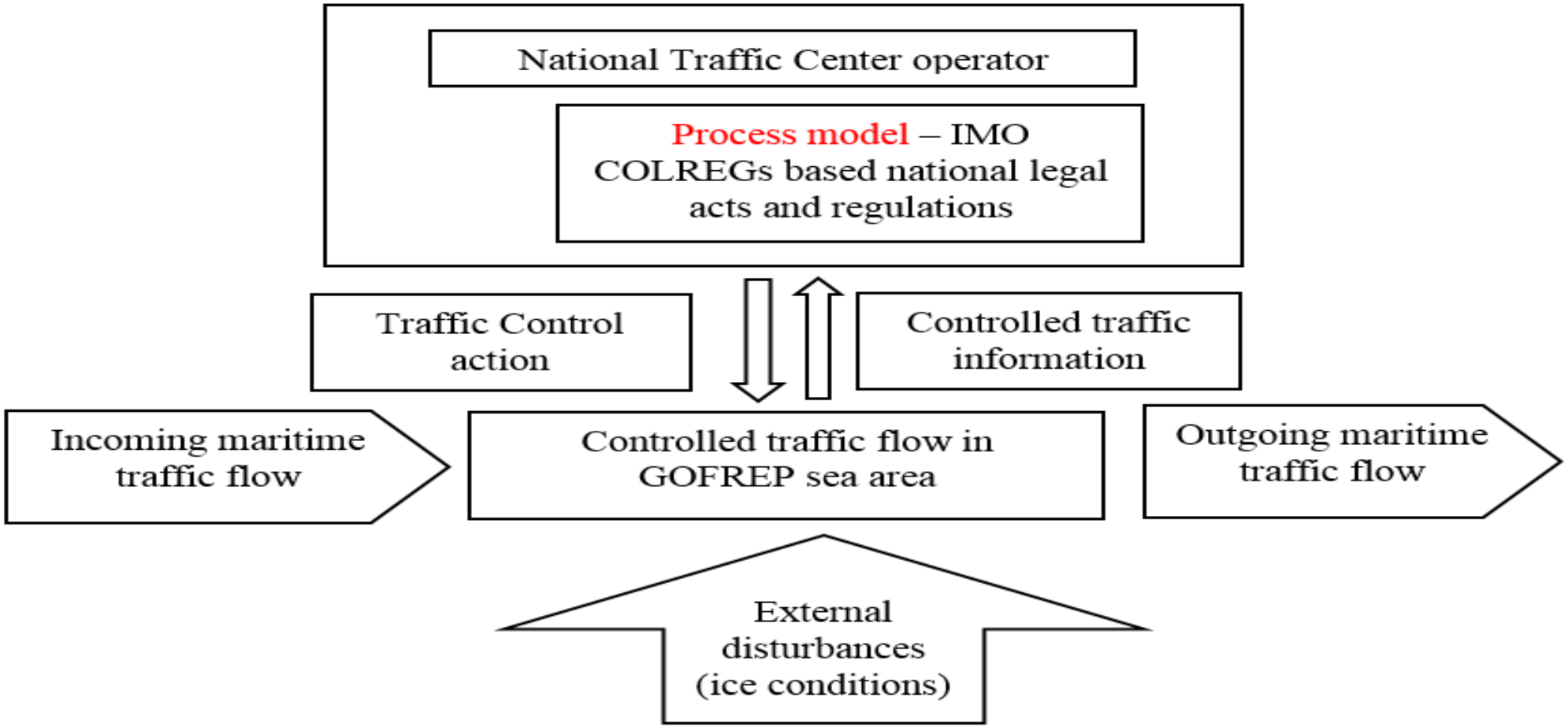
1) radar and Automatic Identification System (AIS) surveillance of traffic in the Ship Reporting System (SRS) area with a particular attention to the development of conflicts in vessel traffic and to detection of COLREGs contraventions,

2) radio communication, and

3) the maintenance of direct and separate communication links between the GOFREP Traffic Centres for coordination, information update and exchange.

During the period when the Gulf of Finland is covered by ice, ships reporting to the Centre, will receive information on the recommended route through the ice and/or are requested to contact the national coordinating icebreaker for further instructions while the icebreaker gives the route according to the ice situation to the ships which fulfil the national ice class regulations and which are fit for winter navigation

GOFREP - a standard STAMP control loop of maritime traffic navigational safety control system (modified from Leveson, 2011). The GOFREP Traffic Center operator is able to observe the controlled maritime traffic process through the radar and AIS surveillance of traffic in the Ship Reporting System (SRS) area, relate the observation to the process model, and to actuate the process if the vessels under control proceed against COLREGs requirements



STAMP - maritime traffic high level navigational hazards and the International Regulations for Preventing Collisions at Sea (COLREGs) requirements/constraints in the GOFREP area

High level hazards	COLREGs requirements/constraints
Vessel is violating the safe speed limits appropriate to the prevailing circumstances and conditions.	Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.
A pair of controlled vessels violate minimum separation standards.	Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist. Any action to avoid collision shall be taken and, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.
Vessel is violating the Traffic Separation Scheme requirements.	A vessel using a traffic separation scheme shall: 1) proceed in the appropriate traffic lane in the general direction of traffic flow for that lane, 2) so far as practicable keep clear of a traffic separation line or separation zone, 3) normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable, 4) a vessel shall, so far as practicable, avoid crossing traffic lanes but if obliged to do so shall cross on a heading as nearly as practicable at right angles to the general direction of traffic flow.

Directive 2008/56/EC of the European Parliament and of the Council establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

Periodic Integrated Ecosystem Assessments based Good Environmental Status (GES)

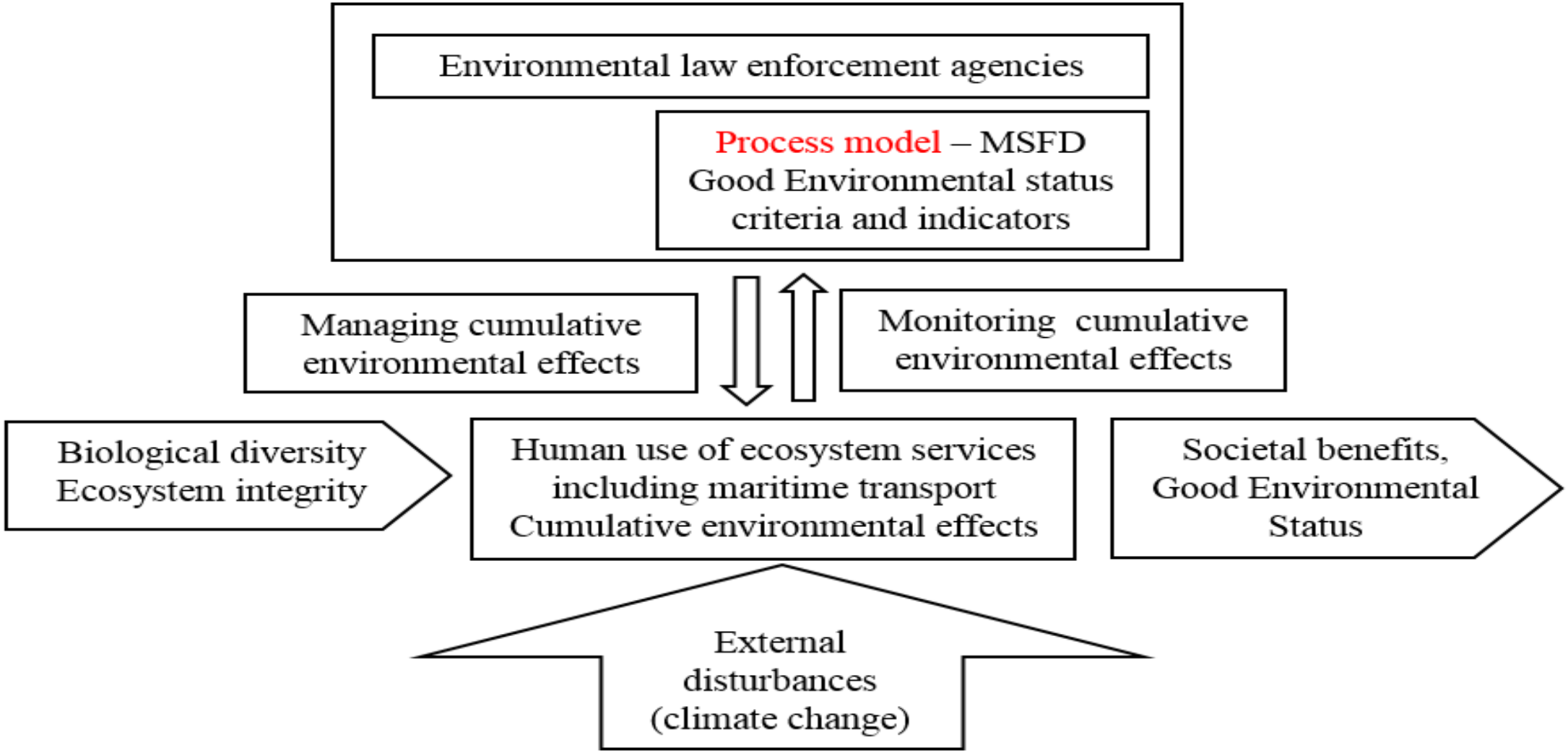
Objective: keeping the values of the Good Environmental Status indicators within the limits of natural variations

Directive 2008/56/EC of the European Parliament and of the Council establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

The marine environment is a precious heritage that must be protected, preserved and, where practicable, restored with the ultimate aim of maintaining biodiversity and providing diverse and dynamic oceans and seas which are clean, healthy and productive.

Directive establishes a framework within which Member States shall take the necessary measures to achieve or maintain good environmental status in the marine environment by the year 2020 at the latest

eSTAMP - a standard control loop of the MSFD Good Environmental Status integrated assessment and management system (modified from Leveson, 2011)



Qualitative MSFD descriptors for determining Good Environmental Status. The right column classifies the descriptors according to presence of corresponding pressure or state criteria/attributes within the descriptor following the DPSIR framework (Berg et al., 2015)

O - direct relevance to maritime transport

MSFD descriptor	Short name	Classification
Biological diversity	D1	State
Non-indigenous species	D2	Pressure/state
Commercially exploited fish and shellfish	D3	Pressure/state
Marine food webs	D4	State
Human-induced eutrophication	D5	Pressure/state
Sea floor integrity	D6	Pressure/state
Hydrographical conditions	D7	Pressure/state
Concentrations of contaminants	D8	Pressure
Contaminants in fish and other seafood	D9	Pressure
Marine litter	D10	Pressure
Energy, including underwater noise	D11	Pressure

MSFD Descriptor 2: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem

International Maritime Organization (IMO) High level constraints

- International Convention on the Control of Harmful Anti-fouling Systems on Ships
- International Convention for the Control and Management of Ships' Ballast Water and Sediments
- Policies, recommendations and regulations developed and agreed at the global, European and regional levels are translated into the national legislation and enforced at the appropriate operational level

MSFD Descriptor 5: Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters

- IMO High level constraints
- International Convention for the Prevention of Pollution from Ships (MARPOL) is addressing the prevention of air pollution from ships (limiting main air pollutants contained in ships exhaust gas, including sulphur oxides (SO_X) and nitrous oxides (NO_X), and prohibiting deliberate emissions of ozone depleting substances. Designation of emission control areas (ECAs) for more stringent control of the emission of SO_X to NO_X and particulate matter (PM).
- Policies, recommendations and regulations developed and agreed at the global, European and regional levels are translated into the national legislation and enforced at the appropriate operational level

MSFD Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

- **IMO High level constraints**
- **International Convention on Oil Pollution, Preparedness, Response and Cooperation (OPRC 1990) and its Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, 2000 (OPRC-HNS Protocol 2000).**
- **Commission Decision (2010/477/EU) - the Member States have to consider the substances or groups of substances, where relevant for the marine environment, that are contaminants and their total releases (including losses, discharges or emissions) may entail significant risks to the marine environment from past and present pollution in the marine region, sub-region or subdivision concerned, including as a consequence of acute pollution events following incidents involving for instance hazardous and noxious substances**
- **Policies, recommendations and regulations developed and agreed at the global, European and regional levels are translated into the national legislation and enforced at the appropriate operational level**

MSFD Descriptor 10: Properties and quantities of marine litter do not cause harm to the coastal and marine environment

- IMO High level constraints
- MARPOL Annex V (Regulations for the Prevention of Pollution by Garbage from Ships). The requirements are much stricter in a number of “Special Areas” but perhaps the most important feature of the Annex is the complete ban imposed on the dumping into the sea of all forms of plastic.
- Policies, recommendations and regulations developed and agreed at the global, European and regional levels are translated into the national legislation and enforced at the appropriate operational level

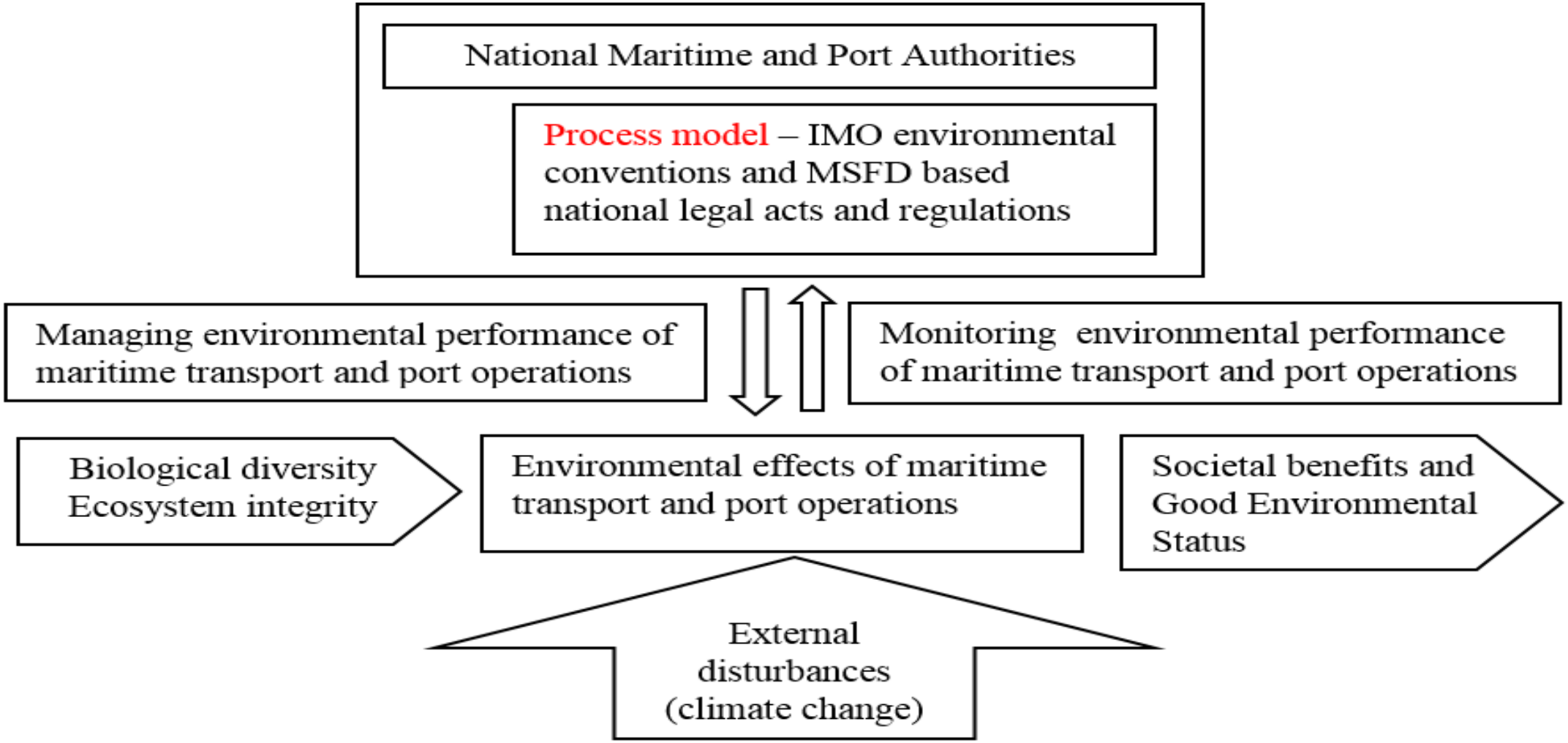
MSFD Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

11.2. Continuous low frequency sound

— Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1µPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate

Policies, recommendations and regulations developed and agreed at the global, European and regional levels are translated into the national legislation and enforced at the appropriate operational level

eSTAMP: managing environmental safety of maritime navigation and port operations – the integrated operational assessment and management



EU Directive 2014/89/EU establishing a framework for maritime spatial planning (MSP)

The Maritime Spatial Planning – from planning to society to planning with society

Maritime Spatial Planning

First of all the MSP is a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process (Ehler and Douvere, 2007)

Transdisciplinary research

- Hirsch Hadorn et al., (2008) state that „transdisciplinary research is necessary when knowledge about a societally relevant problem field is uncertain, when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by the problems and involved in investigating them“.
- Scholz (2000) argues that transdisciplinarity aspires to make the change from research for society to research with society while the Mutual Learning can be conceived of as the adaptation process inherent in interaction and joint problem solving between science and society.

The GAP2 Mutual Learning methodology

Step-by-step approach toward collaboration is comprised of the following steps:

1) **move towards interest based collaborative negotiations,**
2) **understand the other side's thinking,**
3) **focus on shared interests,**
4) **look for solutions to common problems, and**
5) **apply the participatory GIS based Mutual Learning.**

Mutual learning session

EU Directive 2014/89/EU establishing a framework for maritime spatial planning (MSP)

- When establishing and implementing maritime spatial planning, Member States shall consider economic, social and environmental aspects to support sustainable development and growth in the maritime sector, applying an ecosystem-based approach, and to promote the coexistence of relevant activities and uses.
- Through their maritime spatial plans, Member States shall aim to contribute to the sustainable development of energy sectors at sea, of maritime transport, and of the fisheries and aquaculture sectors, and to the preservation, protection and improvement of the environment, including resilience to climate change impacts.

Maritime Spatial Planning (MSP) is becoming an increasingly important issue for the shipping sector over the next few years

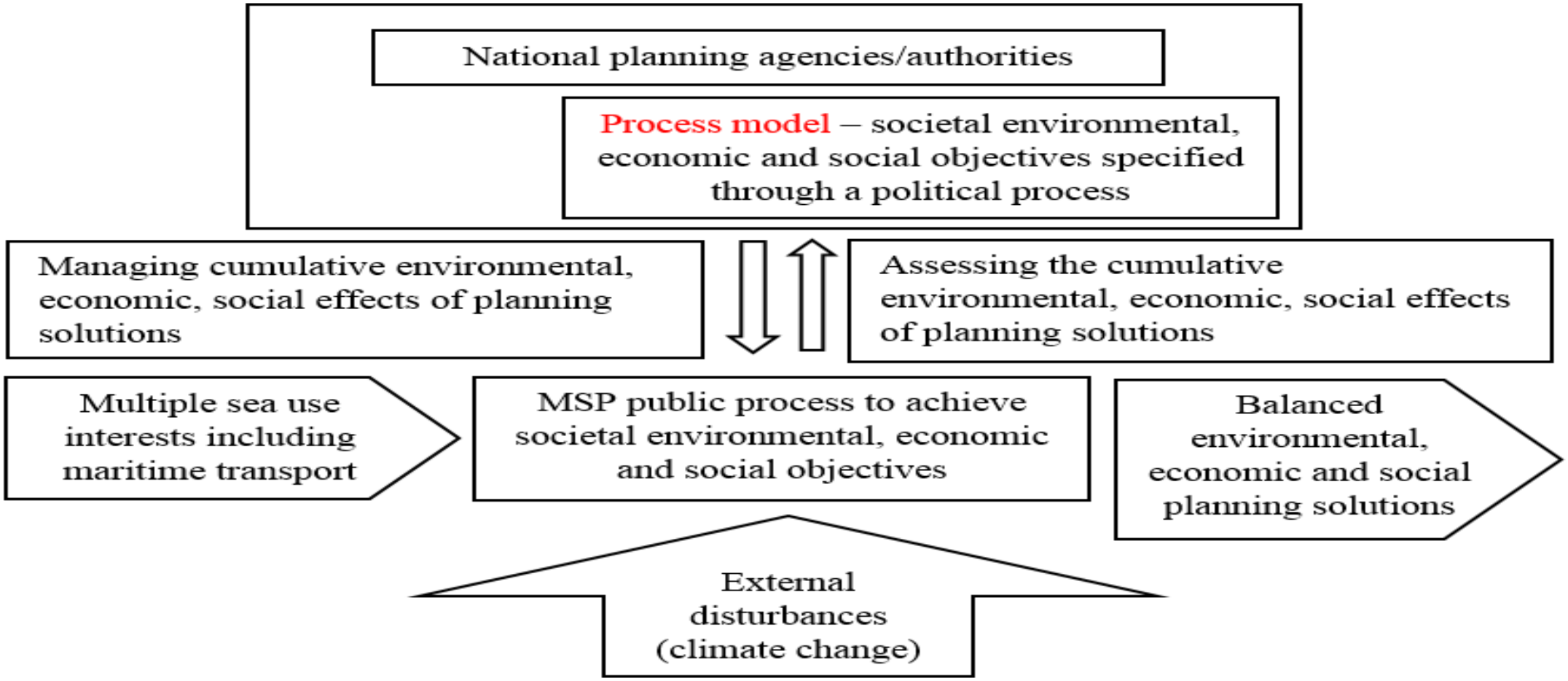
1) Maritime professionals need to engage with other users of waterways space, from both a sea and shore perspective, and
2) to take part in international, regional, national and local MSP debates, to ensure that the needs of the shipping sector are taken into full consideration and that the sector understands the needs of other marine users and resources.

Some issues of critical importance

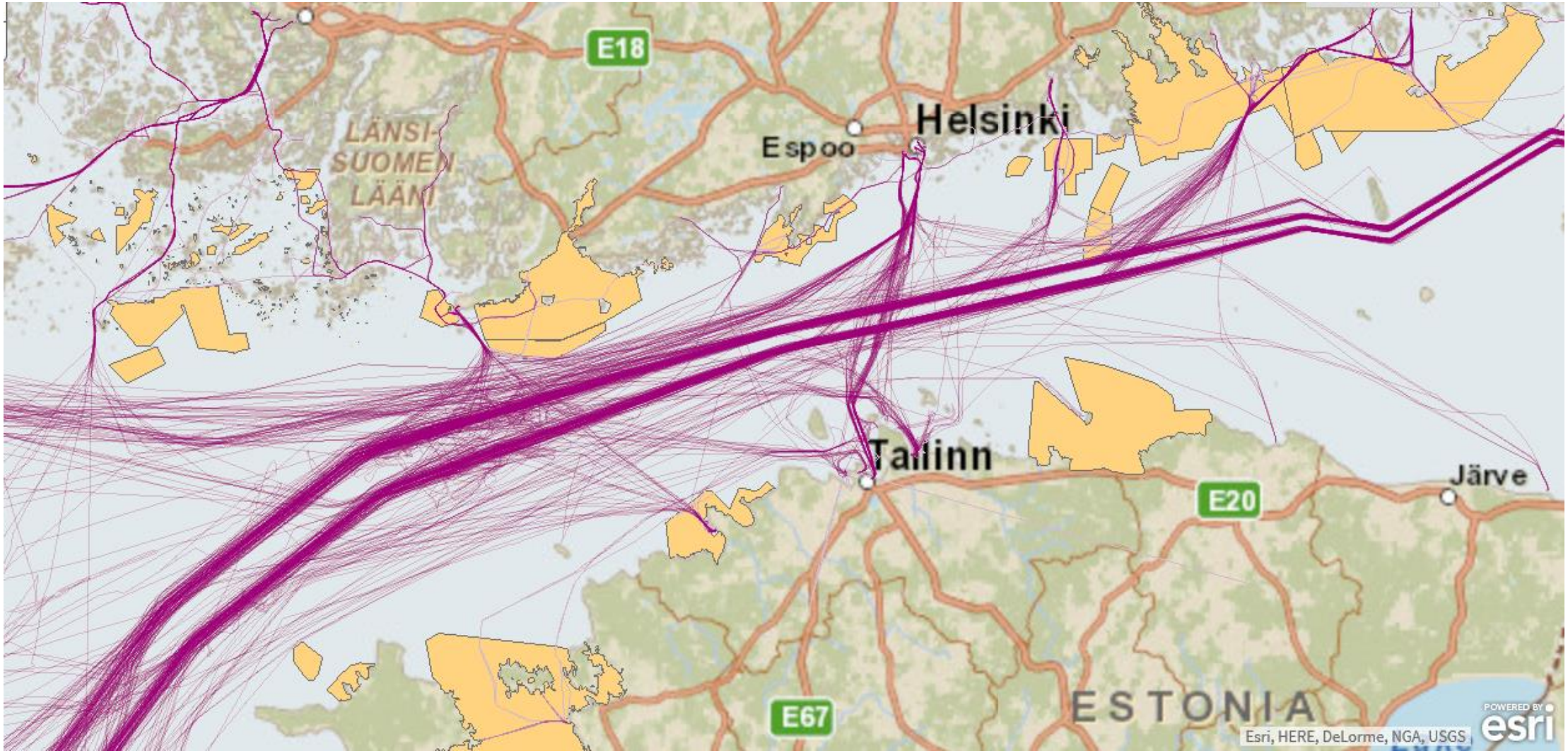
1) when considering the rerouting of shipping lanes or the placement of MSP limitations on sea space i.e. offshore energy installations, the manoeuvring characteristics of vessels must be considered both for normal and abnormal conditions,
2) the constraint should be observed that four ships should safely be able to pass each other in a shipping lane and a distance between overtaking and meeting vessels of two ship's lengths should be normally maintained as a minimum passing distance,
3) anything that might interfere with visibility or radar conspicuity including a physical object, electronic interference or even light pollution, either at sea or on the shoreline must be taken into account when assessing the impact on shipping by other marine users under an MSP plan,
4) impose the isolation zones for different ocean users such as commercial shipping, fishing and leisure craft in a case of increased traffic density in increasingly constricted water space,
5) in addition to navigational safety risks assess the impact rerouting may have on the environment and commercial operations.

The vision

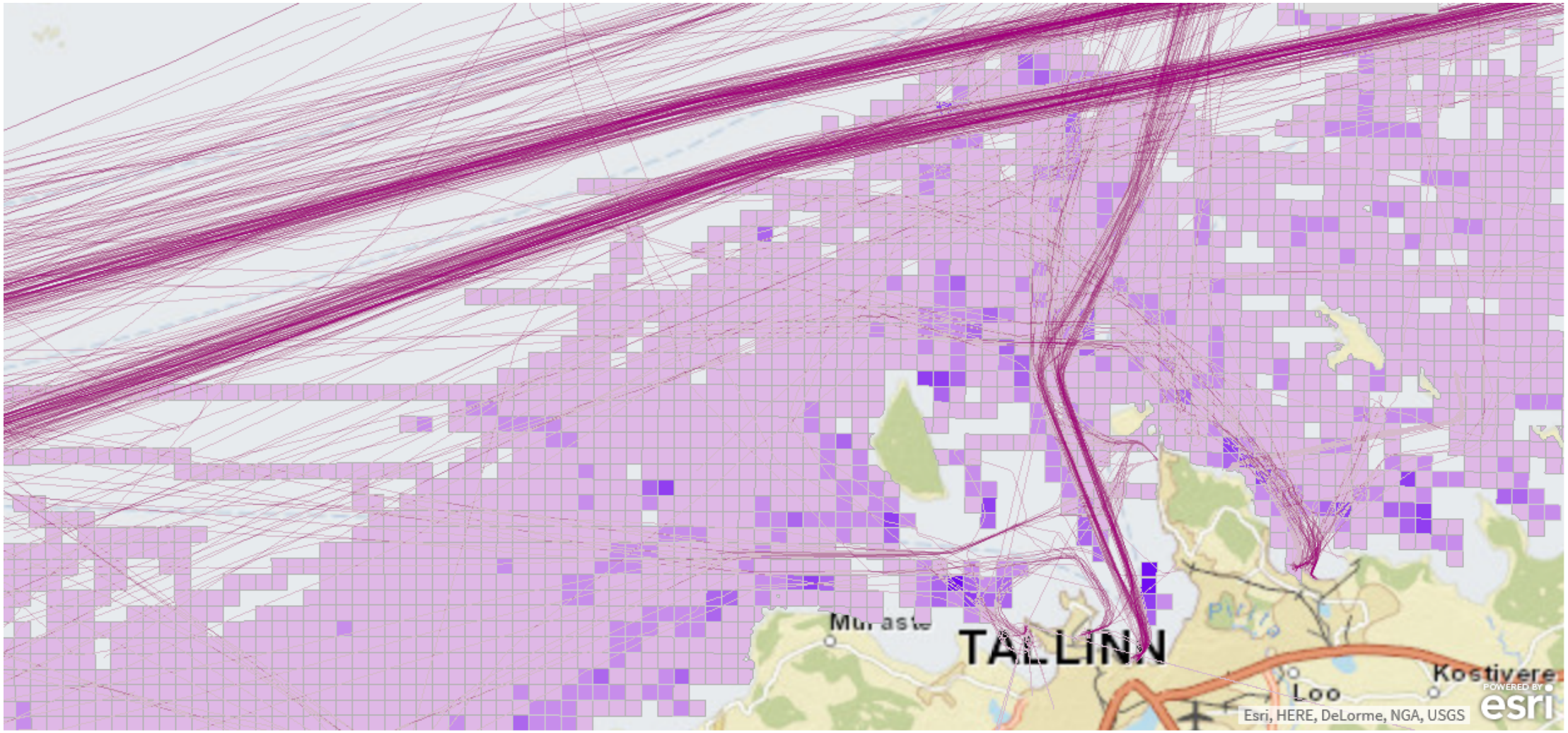
eSTAMP - a standard control loop of the Maritime Spatial Planning quality management system (modified from Leveson, 2011)



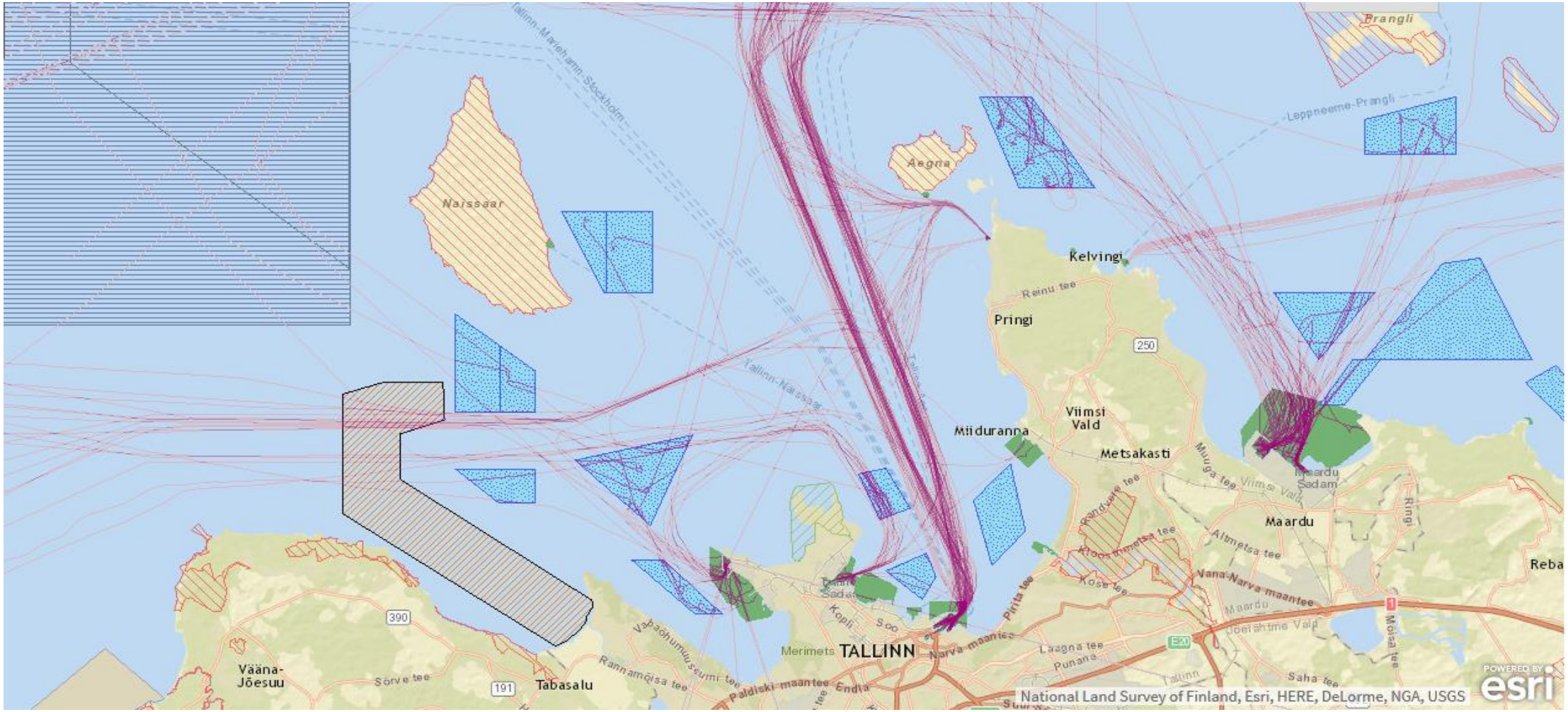
Maritime traffic Automatic Identification System (AIS) tracks and the HELCOM Marine Protected Areas (yellow) in the Gulf of Finland



Maritime traffic Automatic Identification System (AIS) tracks and Estonian trawl fishery spatial distribution (Electronic Reporting System) in the Gulf of Finland



Spatial distribution of different human activities in the Tallinn Bay area



Conclusions

The STAMP concept can be extended beyond the area of socio-technical system safety into realm of safety of complex eco-socio-technical systems (eSTAMP)

The GOFREP Case Study is used as the test bed for the practical implementation of eSTAMP based dynamic safety management of eco-socio-technical maritime transport system

Acknowledgements

The research reported in this paper is performed in the project "Strategic and Operational Risk Management for Wintertime Maritime Transportation System (STORMWINDS)". This project has received funding from BONUS, the joint Baltic Sea research and development program (Art 185), funded jointly from the European Union's Seventh Programme for research, technological development and demonstration and from the Estonian Research Council and the Academy of Finland.

Thank you very much for your attention!