ICEWISE: A gaming environment to test the effects of sea ice forecast reliability on voyage planners' confidence

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Abstract

In the project *Enhancing the Saliency of climate services for marine mobility Sectors in European Arctic Seas* (SALIENSEAS) running 2017-2020, a multinational consortium of scientists have worked together to improve climate services for maritime actors in Arctic waters. At its core the project coproduces improved (sub)seasonal sea ice forecast and ice berg detection services with metservice experts and end users by probing ways these services can reduce uncertainties for stakeholders. We present a novel approach to exploring the effects from the reported reliability of sub-seasonal sea ice forecasts on the user's perception of uncertainties during voyage planning. Our methods combine a participatory scenarios process and serious gaming techniques in the computerized simulation gaming environment ICEWISE. We introduce the game and preliminary efforts from test rounds conducted with five participants with expertise in Arctic marine operations. To conclude, we reflect on the coming stages of data collection that will culminate in an exploratory model. The model serves to inform sea ice service providers of the potential mediating effects from the reliability of sea ice forecasts on the user's own perceived confidence in successful voyage planning.

SALIENSEAS
CO-PRODUCING CLIMATE SERVICES

Introduction

Arctic communities and maritime sectors that depend on either the presence or the predictable absence of sea ice, are seeking decision support for an ever-uncertain operating environment [1]. This puts experts who provide information services, such as the meteorological institutes that provide ice charts and forecast products, on the front lines of managing rapid change by the design and innovation of user-centric services.. In the SALIENSEAS project, downstream services are developed in a collaboration of meteorological institutes, social scientists and end-users. A focus is on marine Arctic monitoring and forecasting on weather and seasonal time-scales and weather and sea ice services and dissemination systems dedicated to Arctic marine end-users that are tailored to their key social, environmental and economic needs.

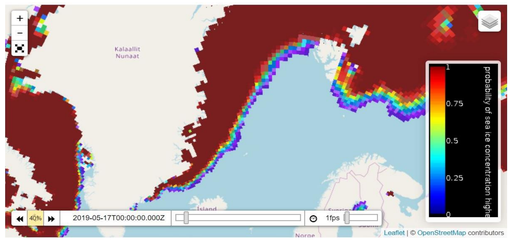

Fig. 1 screenshot of seasonal forecast of sea ice probabilities (MET.no). Colors correspond to probabilities for sea ice concentrations of at least 15%.

Project partners at the Norwegian Meteorological Institute (MET.no) have developed a seasonal forecast of sea-ice probabilities in the Arctic based on ECMWF's (European Centre for Medium-Range Weather Forecasts) seasonal prediction system. The sea ice map shows probabilities for concentrations greater than 15% for the following 6 months. The reliability of the forecast is provided for users, and depends on its range -how far out it is viewed- and the season. A question we are investigating is: how does the sea ice forecast's reliability impact the user's confidence in the decisions they take informed by the forecast?

Game Development

Our research relies on participatory modeling [2] to understand the dynamics of sea ice services as a decision support tool. We designed a simulation gaming environment that integrates the sea ice product, voyage planning and game mechanics such as reward collection, story-based narrative and roll the dice elements based on realistic chance events. The game simulates current conditions, as well as a plausible 2035 scenario.

Geopolitical stability	Accessibility of Arctic sea routes	User-centric information infrastructures and data	Global economic trends	Demand for Arctic resources	Regulations and policies affecting Arctic operations	Major incidents and critical events	Predictability of sea ice variability	Fluctuating energy prices	China's strategic plans	Sustainable and resilient local communities	Trajectory of development in marine technologies
Cake for everyone	Easy access	Global harmonization	Arctic rush	Seafood first	Arctic 5 harmony	Ship crash	Breakthrough	Northern push	Mad Max	Expat haven	Techno-utopia for some, stormy seas for others
Status quo (occasional bullying)	Difficult access	Few specialized, big actors	High-cost closing off	Tourism first	Economic and commercial uses dominate	Status quo	Gradual improvement of predictive models	Northern blockade	Chinese finger curls	Education boost	Slow innovation and adoption
Cold War 2	No access	No development toward harmonization		Fossil futures	Environmentally driven regulation and policy		Unforeseen changes			Tax haven	
					Fragmented, soft regulatory regime						

Fig. 2 Scenario results: key factors (dark blue column headers), future projections (below each key factor heading), and most robust scenario bundle shown by the red line.

In phase 1 of game development we explored the often neglected [3] indirect social forces influencing and being influenced by, available forecast products and services. We engaged experts in Arctic maritime planning, policy and sea ice services in a participatory scenario workshop. The deliberations focused on factors that impact information needs for safe, sustainable Arctic maritime operations now and through 2035. The workshop produced 12 key factors, with 2-4 future projections with narrative description for each [4]. Robustness analysis [5] of all future projections produced a 2035 scenario bundle. The status quo conditions for each key factor were also described in short narratives for a 2019 scenario. The game's story-based narrative was developed and illustrated based on these narrative scenarios, to offer 2019 and 2035 playing modes.

Fig. 3 Sample illustrations for the game's wild card events.

The game is tailored to the cruise industry. In 12 rounds players view a variety of itineraries and select the earliest possible date for the voyage. They invest money and record their certainty about chances for success. The earlier the selected date, the greater the winnings but so is the risk of failure. Players then view sea ice forecasts with varying degrees of reliability and update their choices if needed. Winning or losing each round is based on a probabilistic algorithm using the forecast's reliability estimate.

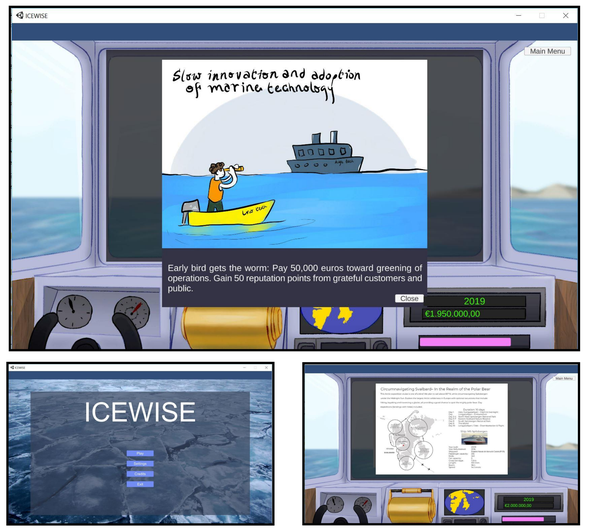

Fig. 4 Screenshots from ICEWISE. Game was developed using Unity Engine.

Testing Rounds

We tested the beta version of the game with five participants in collaboration with Oceanwide Expeditions in Vlissingen. Participant feedback was used to fine-tune the gaming environment.

Fig. 5 ICEWISE testing session with Oceanwide Expeditions.

Future Work

ICEWISE will be deployed at a gaming lab in early 2020. We will collect data through the game and from the debriefing interview of participants following the session. We plan to build an exploratory agent-based model to illustrate possible effects of sea ice forecast reliability on the users' level of confidence in the decisions they take.

References

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