

Ice2sea Internal Deliverables



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Report:

The ice2sea Stakeholder Review is an exercise to assist in the external communications of ice2sea and the effective delivery of sea-level rise projections and advice to relevant stakeholders. The delivery of this outcome is substantially overdue, reflecting the unforeseen difficulties that were encountered in the delivery of one activity, the Stakeholder Questionnaire. However, the deadline initially scheduled was, in hindsight, too early in the project timetable. Although the delivery is delayed, the review is timely for the required purpose, which was to inform the external communications in W6.5 (Final Delivery), which is not scheduled to begin until Month 42.

When so many scientific projects are aimed at delivery of advice and data into complex policy fora, and informing public debate, it is perhaps surprising that many scientific programmes appear to have only hazy understanding of the identities, appetites, and capacities of the stakeholders of their science. A search for similar exercises on which to model the ice2sea Stakeholder Review provided very few examples. Most of those that were identified fell into one of a few categories: those aimed at validating the existing activities of a particular organisation¹, those that appeared to be closer to market surveys for particular products or services², and those that were academic/operational assessments of conflicting interests³. Only a very few examples of similar exercises were found⁴, so given the lack of a comparable review exercise, the ice2sea Stakeholder Review was something of a new venture, which, in the event, required a great deal more dedicated staff time than was expected or initially allocated (1.5 months). However, the lessons learned, which are highlighted through the review document, will undoubtedly assist in the presentation of ice2sea output and ensuring effectively delivery of the science outcomes.

¹ For example, http://www.ncpta.org.uk/information/122288/122394/123100/stakeholder_review/

² For example, http://www.wrgcsrreport.co.uk/index.php?option=com_content&view=article&id=37:stakeholder-review&catid=12:verification&Itemid=15

³ For example, <http://people.exeter.ac.uk/rwfm201/cbbia/downloads/grants/limpopo-tca.pdf>

⁴ For example, http://www.statistics.gov.uk/downloads/theme_health/Report-on-review-of-health-expectancies-Nov-08.pdf



Ice2sea Stakeholder Review



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1. Summary

The ice2sea Stakeholder Review is an study undertaken in support of the final delivery of the EU Framework-7 programme ice2sea, whose aim is to improve the science underpinning predictions of the future contribution of continental ice to sea-level rise, and to provide a new set of projections as an aid to policy-makers and to the wider debate regarding adaptation and mitigation to sea-level rise.

The Stakeholder Review took the form of a series of interviews and encounters between the authors and individuals identified as key or representative stakeholders, and a specific Stakeholder Questionnaire. Together these activities allowed the identification of 17 lessons that will be used to establish a best-practice guide in the delivery of the ice2sea science outcomes.



2. Background

Ice2sea is a programme with the stated goals of: improving understanding the key processes that cause glaciers and ice sheets to contribute to sea-level rise, providing tools that can be used to project the future contribution of continental ice sea-level rise, training a new generation of glaciologists and ice-modellers, and finally, producing projections of the contribution of continental ice to sea-level rise to 2200 on the basis of specific greenhouse-gas emission scenarios.

The first three of these goals is a long-term legacy to this area of science that can be delivered through routine business (peer-review papers, keystone dataset, a cohort of postdoctoral researchers trained across a range of disciplines). However, the effective communication of the projections of the contribution of continental ice to sea-level rise, which is key to the delivery of ice2sea outcomes and thus to the overall success of the programme, was identified in the proposal and “Description of Work” (Annex I of the Grant Agreement) as requiring special management to achieve the optimum communication to the stakeholder community. In particular:

- “Whereas underpinning scientific discovery and improvement in knowledge, even the acquisition of data, can have a long-lived and in some cases permanent effect on scientific thought, ice2sea projections, in common with all other climate projections, will have a limited shelf-life before they are be superseded by more complete, and arguably more advanced projections. For this reason it is important to maximise the impact of the projections within the period for which they are fresh.”
- “The nature of ice2sea’s role, which is focussed on the contribution of continental ice to sea-level rise, means that there may be a significant gulf between the projections that ice2sea will produce and what many stakeholders would hope for (regionally specific projections of the changing risk of coastal flooding and erosion).”
- “The delivery of ice2sea’s projections coming, as it will, alongside similar products and advice from other organisations, needs to be managed so as not to increase uncertainty beyond what is a reasonable and true reflection of the remaining scientific uncertainty surrounding the issues.”

The exercises leading to the ice2sea stakeholder review were intended to establish the answers to specific questions about the needs of stakeholders and their perspective so as to allow effective targeting of key messages, routes for delivery, target audience, and finally, the treatment of uncertainty.

The last of these (treatment of uncertainty), is an area of particular discomfort for many scientists, among whom there is a general feeling that there is rather poor level of understanding regarding the nature of scientific uncertainty in many areas of policy-making. This is compounded by a widespread mis-representation of quantified estimates of uncertainty (which might be more correctly termed “certainty”) as evidence of ignorance or disagreement in the scientific community. It is true that recent reports, such as those from the Intergovernmental Panel on Climate Change (IPCC), tend to include only a summary level of uncertainty information, conflating the several sources of uncertainty⁵ (“unpredictability”, “structural uncertainty” and “value uncertainty”). The aspiration of the ice2sea programme to attempt to make clear the dissociated sources of uncertainty in such projections, in such a way as to guide the allocation of future research effort, will

⁵ Meehl, G. A., et al. (2007), *Global Climate Projections, in Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change edited by S. Solomon, et al., pp. 749-845, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.*

mean that communication around uncertainty will require special attention, and requires us to have some knowledge of the degree to which our stakeholders understand concepts surrounding uncertainty. Similarly, the timescale of projections that are most meaningful to particular groups of Stakeholders is not immediately obvious, nor is the threshold of likelihood beyond which low-likelihood events become insignificant.

The original requirements of the stakeholder review, as defined in the Description of Work, are given in Appendix A. The following review was compiled using series of interviews, and encounters between the authors and individuals identified as key or representative stakeholders since the beginning of the ice2sea programme, and a specific Stakeholder Questionnaire run specifically in support of the Stakeholder Review. Together, these allowed the identification of lessons that will be used to guide best-practice in the delivery of the ice2sea science outcomes.

3. An interview with the Insurance Industry

Appendix B includes an account of discussions held between ice2sea and a prominent global insurance and reinsurance broker, the Willis Group Limited. The conversation was enlightening, but ultimately disappointing. It indicated that despite the size of this market sector, especially in the UK, and its recent and projected growth through European markets⁶, the insurance industry has little direct interest in sea-level rise projections beyond the timescale of 3-5 years. This is the timescale on which insurance premiums are set, and this is the timescale on which profit margins must be guaranteed. However, this does not mean that the industry is unaffected by projections, and certainly not that the consumer is immune to the impact of sea-level rise.

The reliance on commercial insurance to cover flood risk is highly variable across EU countries with coastlines open to the open ocean⁷. Reliance on commercial insurance is highest in UK, but is reportedly also high in France, Spain, Portugal (>50% market penetration)⁸. In some countries, notably, Belgium, Netherlands, and Denmark, government-backed schemes offering insurance or compensation operate on either *ex ante* or *ex post* financial models. However, with the increasing interest of commercial concerns in the flood insurance market, it is worth considering the impact of sea-level rise projections. In the example of the UK, which is most reliant on commercial insurance is a good starting point for understanding the present market, and is likely an indicator for the future in other countries.

Currently in the UK, flood risk insurance is priced by a commercial market on the basis of perceived risk, or actuarial⁹ risk. The pricing is thus calculated according to an insurance company's assessment of the likelihood of flooding, and the tools used for making such calculations are kept in commercial confidence. However, the UK Environment Agency gives the general public access to similar tools¹⁰, which allow identification of areas that are at low (less than 0.5 % per year), moderate (0.5 % to 1.3 % per year) and significant (1.3% per year) risk of flooding due to river and marine inundation. Increasingly, the UK population is using such maps to

⁶ *Climate change could increase the annual costs of flooding in the UK almost 15-fold by the 2080s under high emissions scenarios. If climate change increased European flood losses by a similar magnitude, annual costs could increase by a further \$120 – 150 bn (€100 – 120 bn). Association of British Insurers (2005), Financial Risks of Climate Change, 39 pp, Association of British Insurers, London.*

⁷ *i.e. countries whose flood risk is likely to be altered by global sea-level rise.*

⁸ *Bouwer, L. M., et al. (2007), Adaptive flood management: the role of insurance and compensation in Europe, paper presented at Amsterdam Conference on the Human Dimensions of Global Environmental Change, Amsterdam, The Netherlands, 24-26 May 2007.*

⁹ *Based on statistics of past events.*

¹⁰ <http://www.environment-agency.gov.uk/homeandleisure/37837.aspx>



determine the risk of flooding prior to buying a house. Given that in the UK, house purchase is considered as a very long-term investment¹¹, even the perception of depreciation on the multi-decadal timescale could have an immediate impact on property value. With a high likelihood that in the near future, maps of flood risk will begin to take account of sea-level rise, it is likely that a redrawing and expansion of these zones of risk will mean that many properties currently at low or negligible risk will become included for the first time, and many already at medium risk will move to a higher category of risk. Clearly, for many consumers, insurance premiums will rise, but more significantly, it is possible that where the risk of coastal flooding for a specific property is increased by sea-level rise so that it exceeds a particular threshold¹² then commercial insurers will no longer offer cover on it. The likely consequence will be that it would become impossible to secure a loan (mortgage) on such a property, and it would consequently be worth only a fraction of its present value. Especially in the UK, the sensitivity of housing markets to such perceptions has routinely been boosted by intense media coverage, encouraging catastrophic (*sensu stricto*) market responses.

Lesson #1 for ice2sea communications. It might be argued that the most compelling approach to communicating the importance of understanding sea-level rise, and the significance of ice2sea projections, would be through a quantitative description of the changing risk of flooding for specific highly vulnerable areas. However, a focus on such regions as case-studies could potentially have a significant deleterious effect on property owners in that area. *Care must be taken by ice2sea communications to deal with regions fairly, and consider the potential implications in rather generalised ways, keeping in mind the potential effects on individuals and regions. Case studies highlighting vulnerability must only be used with considerable caution.*

4. Two views from the UK Environment Agency

Discussions with two levels of coastal-defence planners working within the UK Environment Agency have been undertaken in support of the ice2sea Stakeholder Review. These provide a very different perspective on the requirements of planners from information.

4.1. Protecting London

(Source: Tim Reeder, Regional Climate Change Programme Manager at Environment Agency. Discussions prior to commencement of ice2sea, and discussions at British Antarctic Survey, 19th May, 2011.)

We reported in the ice2sea proposal, and Description of Work, prior discussions between sea-level rise researchers at British Antarctic Survey and the Met Office Hadley Centre with UK Environment Agency – the body responsible for planning flood defence for London. During those discussions it emerged that certain features of sea-level rise projections are highly significant to planners, but are not currently available from most projections. In particular, it is not a high rate of sea-level rise that concerns the Environment Agency most with respect to protecting London, but the possibility that the rate of the rise could change dramatically

¹¹ It is common for leasehold properties in the UK to be considered unsaleable if the lease is less than 60 years, e.g. http://www.home.co.uk/guides/buying/leasehold_freehold.htm.

¹² Currently, it is expected that domestic residences whose flood risk is not excessive should be able to access commercial insurance for a premium of 0.5 % of the sum insured amount per year. However, the interpretation of the level of risk that constitutes “excessive” is not entirely clear.



within a couple of decades, allowing insufficient time to plan and build infrastructure, or substantially reducing the lifetime of recent investments in sea defence. A better understanding of the potential for “surprises” within the projections, has allowed the Environment Agency to draft the policy for maintaining the flood risk to London over the next 100 years (“Thames Estuary 2100”, TE2100)¹³, this is based on a staged response, with thresholds of sea-level rise triggering the start of particular planning responses. This approach required that the Environment Agency focused almost exclusively on the highest rates of sea-level rise that might be seen in the Thames Estuary. After all, if a plan could be demonstrated that would deal with the highest rates of sea-level rise, then it would clearly be possible to formulate a plan to deal with a lower rate.

Lesson #2 for ice2sea communications. Ice2sea communications should include the important key message that good quality science that increases knowledge and reduces uncertainty will allow delay or complete avoidance of unwarranted expenditure on sea-defence and adaptation. Delaying decisions can often increase the effectiveness of expenditure.

Lesson #3 for ice2sea communications. A full description of sea-level projections must include some effort to define the maximum plausible rate, rates of change, and potentially magnitudes of sea-level rise, even if these cannot be fully simulated by computer models. Ice2sea communications should include low-likelihood, high-impact scenarios, even if these cannot be fully simulated by the current generation of climate and ice models.

Lesson #4 for ice2sea communications. A lack of understanding of maximum rates of sea-level rise may, in some sectors, cause a mis-interpretation of uncertainties in sea-level rise projections, if these are not presented or updated correctly. Ice2sea communications should not assume knowledge in stakeholders which they may not have. For example, uncertainty about total sea-level rise by 2050, decreases for every year that passes (as year-by-year, “possible future sea-level rise”, becomes “past measured sea-level rise”). Thus periodic reassessment of sea-level rise is required, and will mean updating the most likely scenarios. Without an understanding that rates of sea-level rise, and rates of change of sea-level, can be constrained within practical limits, this point could be overlooked, together with the opportunity it provides for planners to develop a sensible adaptation policy, based on a structure decision timetable (c.f. TE2100). *Ice2sea communications should assume no prior knowledge in explaining the implications of our projections.*

4.2. Protecting the Norfolk Fens.

(Source: Dr Geoff Brighty – Environment Agency’s Area Manager for Central Anglia. Discussions at British Antarctic Survey, 5th Aug, 2011).

The Fens are areas of marshland or former marshland that cover 3,900 km² of Lincolnshire, Cambridgeshire, Norfolk, and a small area of Suffolk, in the East of England. Most of the Fenland lies within a few metres of sea-level. As with similar areas in the Netherlands, much of the Fenland originally consisted of fresh- or salt-water wetlands, which were artificially drained by a programme that began in earnest around 1630. They continue to

¹³ See: Lavery, S., and B. Donovan (2005), *Flood risk management in the Thames Estuary looking ahead 100 years*, *Philosophical Transactions of the Royal Society a-Mathematical Physical and Engineering Sciences*, 363(1831), 1455-1474. Also: <http://www.environment-agency.gov.uk/homeandleisure/floods/104697.aspx>



be protected from floods by drainage banks and pumps and have become a major arable agricultural region in Britain. The Fens are particularly fertile, containing around half of the Grade 1 agricultural land in England. The areas are currently subject to the competing threats of riverine and marine flooding.

The experiences of Dr Brighty in developing ongoing management plans for the low-lying fens of East Anglia are quite different from his counterpart managing the Thames Estuary. Given the nature of the coastline that includes a major river that is tidal for around 25 km inland, a single line of sea-defence is inappropriate and a more granular approach is required. The present defences centre on various actively-managed sluices that are used to control flow, and “washes” used to manage/store flood water. Finally, the impact of sea-level rise may in future be exacerbated by the silting up of the tidal river, reducing its depth. Given the significance of the areas for agriculture, there is a strong requirement to develop a sustainability plan for the region, with a strong emphasis on ensuring the financial sustainability of the area. Not only is the level of funding available to support protection quite different from that available for protection of Greater London, but the sources of funding are quite different. Landowners themselves will need to cover much of the costs to maintain current levels of protection, whether or not they are supported by grant aid from national or EU government. Thus, they may need to consider their options early, and make explicit provision for future costs over a number of years.

Whilst there is clearly no intention to underplay the possible magnitude of future sea-level rise, the dialogue with landowners who are being encouraged to consider the future costs of protecting their land against flood-risk needs to focus on the “most-likely” scenarios. Given that the current level of risk appears already to be the maximum level of risk that is of acceptable to many, early intervention in spite of incomplete knowledge on sea-level rise may be the only way to proceed. However, it would be difficult to persuade individuals to save to provide protection against low-likelihood events.

This is also an area where there is a growing population, living in localities that suffered significant fatalities during the last major coastal flood in 1953. While there are well-developed civil-defence plans in place for early-warning and evacuation of populations, there are significant concerns that increasing risks arising from climate change, and the potential for a coincidence of risks (for example, a significant storm surge coinciding with significant rainfall on lying snow) which would test the capacity of infrastructure to cope.

Lesson #5 for ice2sea communications. The emphasis on mid-range or upper-range, or maximum plausible estimates of sea-level rise depends on the magnitude and granularity of the risk and those that bear the costs. *Ice2sea communications should recognise that different stakeholders will choose to emphasize different aspects of risk, and that this will reflect the specifics of their own policy arena, and it is beyond the remit of ice2sea to attempt or manage how its outcomes are used.*

Finally, both representatives of the Environment Agency expressed a desire to improve the understanding of their clients of the non-linear relationships between sea-level rise and flood-risk. In particular, it was noted for London that existing sea-defences were designed to give a level of protection roughly equal to an expected exceedance equivalent to once in a thousand years. The analyses of available storm height statistics¹⁴ suggest that, assuming no change in storm frequency or height, a 50 cm rise in base sea-level would reduce the effectiveness of that protection to once in one hundred years. An additional rise of 50 cm, would reduce this further to greater than once in a decade. Such figures emphasise the non-linear impact of sea-level rise, but can also be used in the counter-argument to highlight the relatively modest increases in the height of sea-

¹⁴ Dawson, R. J., et al. (2005), *Quantified analysis of the probability of flooding in the Thames estuary under imaginable worst-case sea level rise scenarios*, *Int. J. Water Resour. Dev.*, 21(4), 577-591.



defences required to significantly decrease the frequency and likelihood of breaches. The discussion of the change in risk for coastal communities and assets must thus take full account of planned and implemented improvements in sea-defence infrastructure.

Lesson #6 for ice2sea communications. The managing of sea-defence in the real world is all about the statistics of risk. Sea-defence planners identify a general lack of understanding of the non-linearity of the impact of sea-level rise on risk, with which ice2sea could assist. However, the non-linearity works both ways and should not simply be presented in terms of increasing risk, the significant caveat that improvements in sea-defence infrastructure have substantial beneficial impacts on risk should not be over-looked.

5. Lessons from Texas

In 2010, as the guest of the UK Foreign and Commonwealth Office, Prof. David Vaughan, attended a three-day conference hosted by The Harte Research Institute for Gulf of Mexico Studies at Texas A&M University-Corpus Christi. This was titled the "International Conference on Sea-Level Rise in the Gulf of Mexico: Impacts, Adaptations, and Management"¹⁵. During the event, 240 participants from different academic disciplines and relevant areas of jurisprudence and policy-making came together to share knowledge on the natural processes and human dimensions of sea-level rise in the Gulf of Mexico. The meeting provided a rare opportunity for a physical scientist engaged in sea-level rise research to engage with decision makers and the public in planning for the future.¹⁶ While the discussions were necessarily focussed on the Gulf of Mexico, several generic lessons and exemplars became clear.

Discussions with a sea-defence manager¹⁷ employed by a US state, suggested that even today, decisions affecting the lives and livelihoods of many US citizens are being made which are strongly influenced by the magnitude of current sea-level rise projections. The manager noted that in the US, an individual property-owner who believes that the level of sea-defence protection provided by the state has been reduced or withdrawn has a strong case for redress through the civil courts. Thus in the US, an individual has the right to sue the state, and this potential cost to the state may mean that some areas of coast are not being defended as aggressively as might otherwise be the case. In essence, the choices made by the state about which areas can be defended and which areas cannot, are, at least in part, informed by expectations of future sea-level rise and the increasing costs of defence as sea level rises. If sea-level rise is expected to be 0.5 m, a state may consider it economic to begin defence of some areas that would be uneconomic if sea-level rise is expected to be 1.0 m. In other countries where the national government can develop a responsive approach to sea-defence, it can in time reduce or withdraw particular levels of protection without facing an unquantifiable bill for compensation or legal defence. In comparison, the US system appears to be inflexible, and perhaps destined to take a pessimistic approach to sea-level rise. However, in practice, the choices facing all governments with significant coastlines are similar, and the cost benefit analysis with respect to coastal development and planning the

¹⁵ <http://www.harteresearchinstitute.org/newsletter/spring2010/article4.html>

¹⁶ *One of the goals of the conference was to offer significant outreach and educational opportunities to the public. To further this effort, all of the presentations were recorded and uploaded so that people across the globe have access to them on the web. In addition, special workshops were held to provide school teachers with information about sea level rise and to support curriculum development. In addition, the public was also invited to attend two free, evening lectures by international scholars. Prof. David Vaughan, spoke on physical aspects of sea level rise in his lecture entitled, "Melting Ice and Rising Seas: Perceptions, Risk, and Reality."*

¹⁷ *Anonymous by request*

longevity of high-value coastal assets is pressing and can only be informed by available sea-level projections, and the effective communication of likelihoods and risk.

Lesson #7 for ice2sea communications. The relationship between the individual and the state is a key factor in our perception of risk and responsibility, which strongly modifies the way that messages are taken up by different stakeholders. In response to the example of the USA, a landowner might want to emphasise the most-likely (mid-range), or even the low estimate, whereas the planner might emphasise the upper estimate. *Communication of ice2sea output needs to reflect the full range of assessments, but also to emphasise that we expect to make progress in refining estimates in the future.*

Lesson #8 for ice2sea communications. The magnitude of sea-level projections is already influencing decisions. The example of the USA suggests that unjustifiably high projections of sea-level rise will, under some conditions, have a paralysing effect on sea-defence planners. This means that sound sea-defence plans that should be considered may not, in fact, be pursued because it is thought that they will eventually be unsustainable. *The ice2sea message should attempt to define justifiable likelihoods to the highest projections, so that undue weight is not placed on the extremes of the distribution.*

6. IPCC Fifth Assessment Review

The requirement for ice2sea to support the writing of the IPCC Fifth Assessment Review has been accepted since the original Announcement of Opportunity. Indeed, IPCC may in some ways be considered as the primary stakeholder for ice2sea, and the success of ice2sea may be judged in some part by how the IPCC authors choose to cite the output from the programme.

There are several areas in which ice2sea outputs may be quoted by the IPCC in Working Group I and II of the assessment: in particular, chapters 4 (Observations of the Cryosphere) and 13 (Projections of sea-level rise) in Working Group I. Eight members of ice2sea have been selected into the IPCC writing team¹⁸, over four chapters. Seven of the 24 project partners are therefore represented in the AR4 report. Although this cannot guarantee uptake of ice2sea results by the IPCC, it does ensure that the IPCC has good visibility of ice2sea science.

The IPCC report writing process is well established, and the communication routes within it are clear for ice2sea. Therefore, this is not considered to be a part of the stakeholder review process. Ice2sea's best method of communicating to the IPCC process remains through the production of good quality, relevant, papers – published in peer-reviewed journals, which is the only material that the IPCC can cite. It therefore remains ice2sea's top priority to produce these manuscripts for review by the deadline of the IPCC, in July 2012.

Communicating our intentions of publications will help to ensure that relevant IPCC authors are aware of the manuscripts that are in preparation, which they should expect to see in the literature over the coming months.

¹⁸ Chapter 4 – Observations of the Cryosphere: David Vaughan (Coordinating Lead Author (CLA)), Frank Paul (LA), Jonathan Bamber (Review Editor (RE)) and Philippe Huybrechts (RE); Chapter 12 – Long-term climate change: Gerhard Krinner (LA); Chapter 13 – Sea-level Rise: Tony Payne (LA), Jonathan Gregory (LA); Chapter 14 – Future regional climate change: Jens Hesselbjerg Christensen (CLA).



To this end, the Co-ordinator gave lists of intended publications to each of the relevant authors that attended the WG I Second Lead Author Meeting on AR5, in Brest, France, in July 2011.

7. Stakeholder Questionnaire

7.1. Introduction

The ice2sea Stakeholder Questionnaire (SQ) was undertaken to provide some quantitative view of requirements of stakeholders and an opportunity for comparative analysis of the requirements of different stakeholder groups. Since ice2sea is funded largely by the taxpayers of the EU, both via Framework-7 and through national support to the participant institutions, we take a wide view of who ice2sea's "Stakeholders" are. Broadly, for the purposes of the SQ, we took the approach that any institution or individual who identified themselves as such, would be welcome to participate in the SQ. We certainly hoped to include key stakeholders, such as representatives of local, regional and national government, EU government, but in addition representatives of commercial concerns, educational groups, campaigning groups, and individual citizens were invited to participate.

In practice, we identified individual stakeholders, through personal contacts, via open invitations on email servers, through internet searches on particular keywords and via particular organisational and institutional websites, and via word-of-mouth nominations. The invitation to the questionnaire was sent by email¹⁹, along with an introduction (see Appendix C) to over 320 key people, and links were also added to the ice2sea website. Links to the questionnaire were added from at least one other website; that of UK's Living with Environmental Change program (LWEC²⁰). The exact forms of the questions given to participants are given in Appendix D. The questionnaire was created and managed using Survey Monkey²¹, as this provided a good user interface, it is a tool many would already be familiar with, and also provided flexible data output facilities and analysis tools. Those that answered the questionnaire, and gave their name (not compulsory) are listed in Appendix E.

The questions (and the introduction to the stakeholder review, Appendix C) were also translated into French, German, and Italian, for ease of completion particularly by local government and advisory groups in those countries. On the advice of the ice2sea partners in other countries (namely, Finland, Denmark, Iceland, The Netherlands, Norway, Belgium, Switzerland, Poland, and Chile), the questionnaire was not translated into more languages, since in these countries English or one of the other languages is sufficiently widely spoken that many stakeholders would not be discouraged from responding by an absence of their native language. In other countries, where coastal flooding is not a major issue (e.g., Switzerland), we assumed that there would be too few respondents interested in sea-level rise to make the exercise worthwhile. In the translated versions, questions were kept the same, so that all responses can be compared and analysed together.

The questions were formulated by the ice2sea Coordinator and Programme Manager, with consultation from the communications professionals in the Press and Public Relations Group at the British Antarctic Survey.

The survey was broken down into five sections. Each of these is discussed in detail in the sections below. The first section aimed to determine what sorts of respondents were completing the survey, so that answers to the

¹⁹ At first, we sent block emails to groups of potential stakeholders, but found that we got a much higher response rate from sending individual personalised emails – naturally a much more time consuming task.

²⁰ <http://www.lwec.org.uk/>

²¹ <http://www.surveymonkey.com/>

other sections could be put in context. The three main sets of questions on sea-level rise were on: understanding of projections; risk, probability, and uncertainty; and delivery of information. The final section included follow up questions, such as who the respondents were and who they represented, and whether they had any further comments.

7.2. Respondents

A total of 146 people responded to the four language versions of the questionnaire.

A proportion of those that completed the survey were researchers, both from within ice2sea and from the larger community (particularly in the USA). While this increased the total volume of answers, we felt it was likely to skew the results, as researchers may well want more detailed and quantitative information than other groups of respondents. For this reason, and with the aim of better determining the needs of the policy makers, several of the responses to the questions are shown with the researchers' answers removed (in addition to the full response set),

The first section of questions was designed to determine the background of the respondent completing the survey, in a way that would allow other replies could be put in context. Figure 1 shows the categories of field in which respondents worked. Answers were tick boxes – so respondents could select as many options as they liked. The private sector includes businesses involved in flood defences, and insurance industries. The public sector respondents include civil servants, including policy makers, elected members of Parliament, appointed members of government, local council members, and members of environmental agencies and government advisory bodies. Other respondents were artists and students.

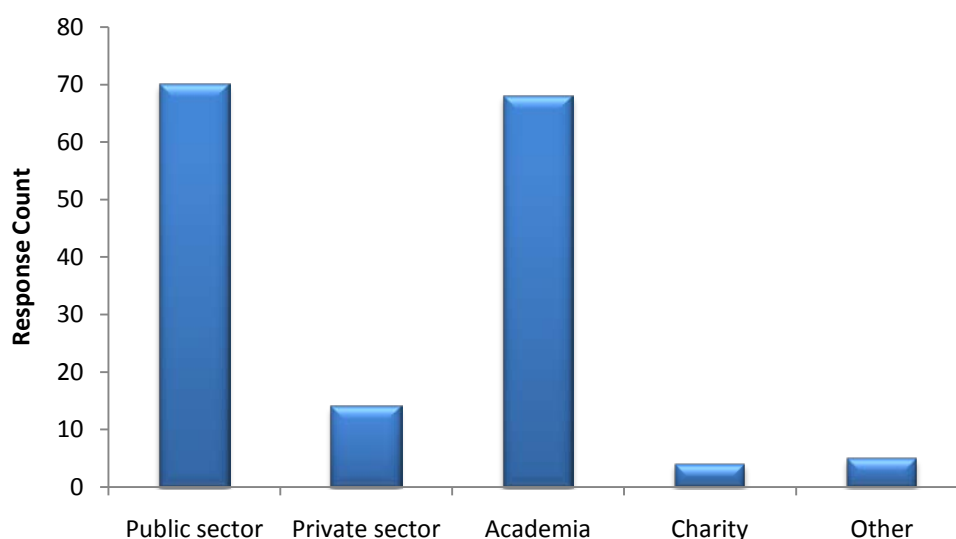


Figure 1. Q.1. In which fields are you active? Multiple answers were allowed to this question, and the chart shows all the responses.

Lesson #9 for ice2sea communications. Our efforts to engage with stakeholders in the private and charitable sectors were less successful than hoped. Either awareness of issues of sea-level rise in these sectors is poorer than in the public sector or academia, or the routes to engagement used by ice2sea need to be improved. However, no matter how we aspire to engage with the widest possible stakeholder community, it should be noted that a sizeable audience for ice2sea

research exists in the academic environment, and failing to serve these interests would be to ignore a ready audience.

We also wanted to determine which areas the respondents worked in (Figure 2). As with Question 1, multiple answers could be chosen. Although from Figure 1 a good proportion work in the public sector, many are still in research – such as government funded research institutes. Those that responded to Question 2 with answers of “strategy” and “implementation” will be analysed separately, in addition to the total respondents, see below. Other fields included public communications, journalism/press/author, and the theatre.

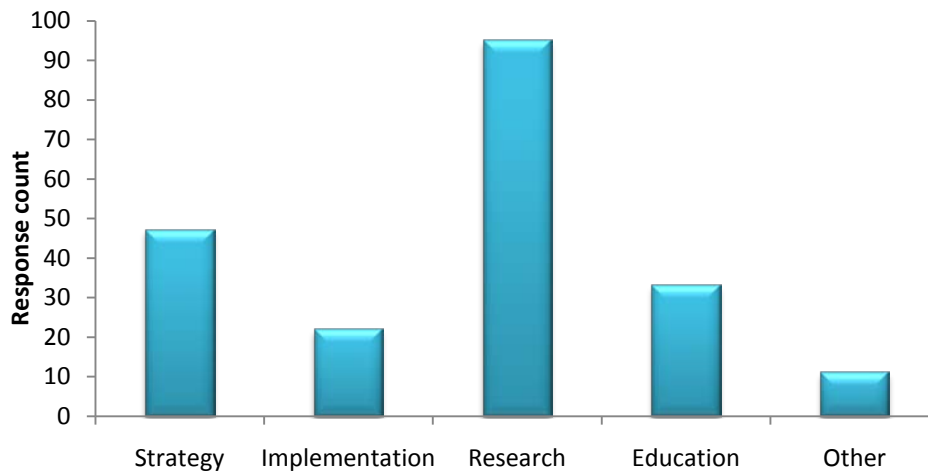


Figure 2. Q.2. Which spheres do you consider that you operate in? Multiple answers were allowed to this question, and the chart shows all the responses.

Our third question was about the context in which respondents use sea-level rise projections. This was designed to allow categorisation of responses into groups that may well have different communication requirements. The distribution of these answers is given in Figure 3. This was a compulsory question (an answer was required to allow progress on to the next question). Multiple answers were allowed per respondent. “Other” respondents were an artist, film researcher, and journalist.

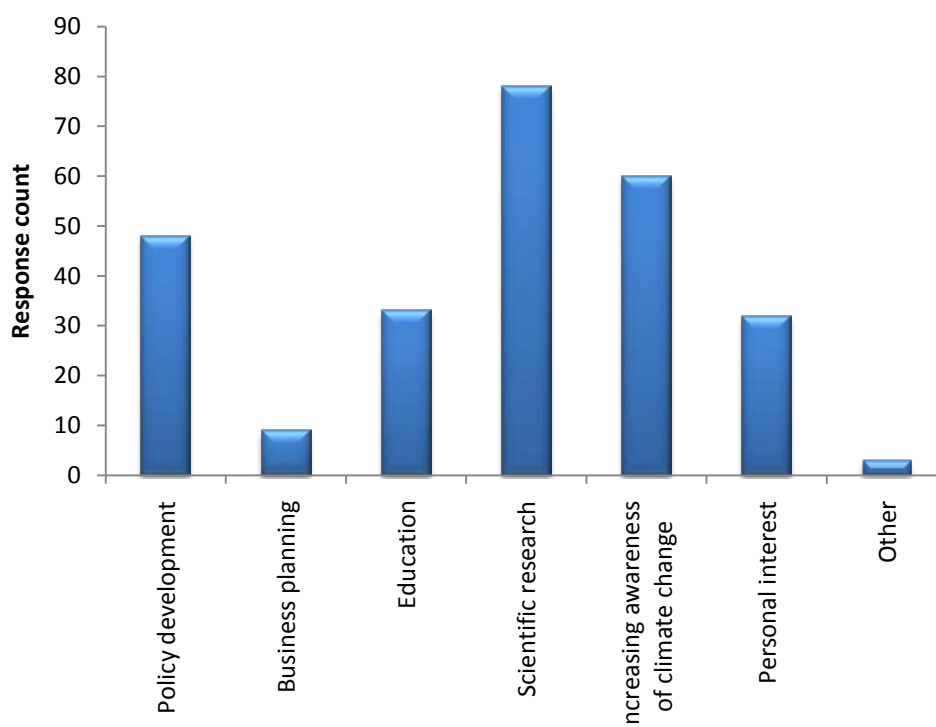


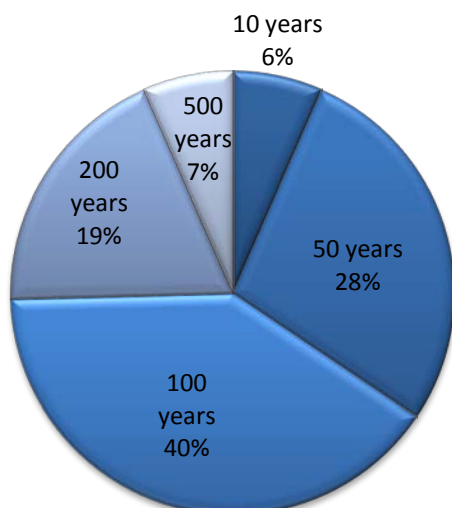
Figure 3. Q.3. In which context do you use sea-level rise projections? Multiple answers were allowed to this question, and the chart shows all the responses.

7.3. Sea-level Projections

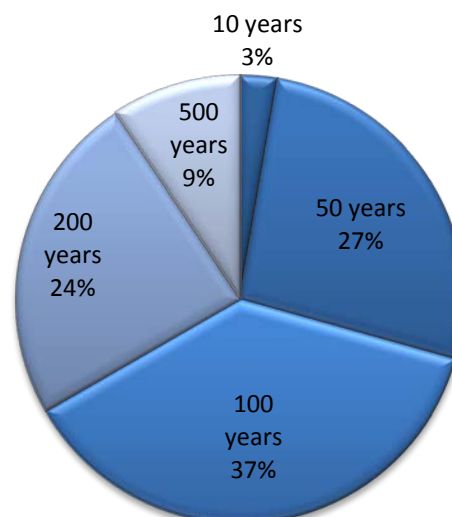
The first of the three main sections was aimed at understanding the respondents understanding and their use of sea-level projections. Although we have an understanding of what projections the scientific community create and make use of, our expectations were that other groups would have very different timescale interests. This is particularly the case for the first of these questions, on timescales of interest (Figure 4).

It should be emphasised that the question was specifically phrased to find *how far* they were interested in, which is essentially cumulative, e.g. if 50 years was selected as a response, it was assumed that the respondent was also interested in what will happen in 10 years time. I.e. it is the maximum time of interest. Only two respondents failed to understand this: their responses have been added to the 500 years option.

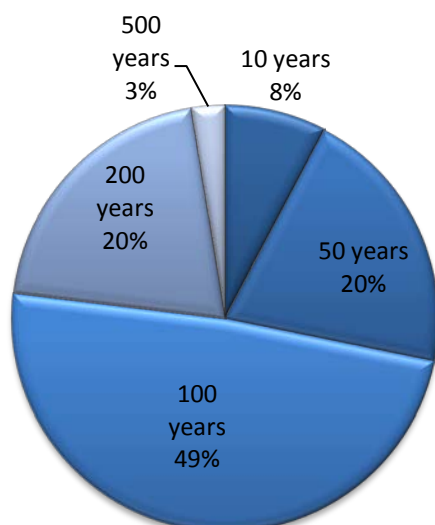
a) All respondents



b) Researchers



c) Strategy



d) Implementation

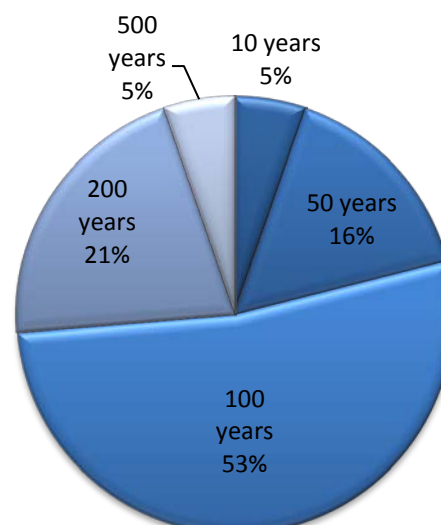


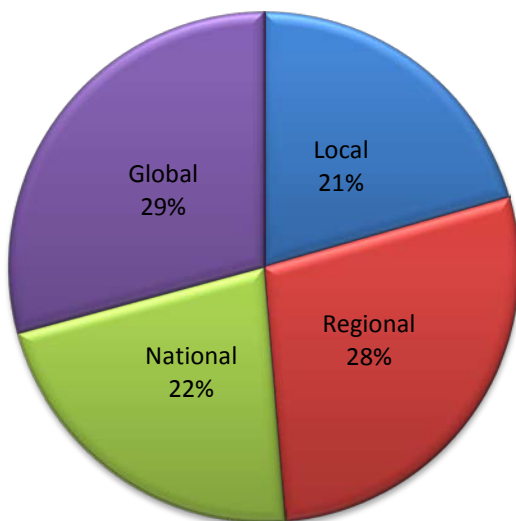
Figure 4. Q.4. How far into the future do you consider sea-level rise projections as being valuable? Separated depending on answer to question 2. a) All respondents; b) Research; c) Strategy; and d) Implementation. Only one answer was allowed to this question. Responses to "Other", no represented in these graphs included: "unsure", "2 years", "300 years" ("sea-level rise really should kick in as a MAJOR problem beyond 100 years"), "1000 years", and "the life-time of the anthropogenic perturbation", which is not particularly clear.

Many previous projections of sea-level rise given in scientific literature and in particular the IPCC assessments (up to AR4 in 2007) looked have focused up to 100 years into the future (or, often to 2100). Of the total respondents, 74% agreed that this timescale is adequate for their purposes. However, more than a quarter of respondents believe it is important to consider sea-level rise projections further into the future than the IPCC's timescale of 100 years, and this is not restricted to researchers, but is moderately uniform across areas of strategy and implementation. This is perhaps surprising, insofar as those involved in implementation have such long-term requirements: we had expected a greater proportion of interest in this sector, with its emphasis on practical planning and budgets, to be of a short term nature.

Lesson #10 for ice2sea communications. One of the important differences of the ice2sea project to other previous work is the intended focus on a timescale of 200 years. While most stakeholders understandably focus on shorter timescales, there is a significant interest in such long-term projections, and the emphasis of ice2sea communications needs to reflect this.

As well as the temporal scales discussed above, we were also interested in the spatial scales that are of interest to our stakeholders. Figure 5 shows the responses to Question 5, from which multiple answers to the four questions were allowed. This shows a surprisingly even distribution of scales of interest.

a) All respondents



b) Non-researchers

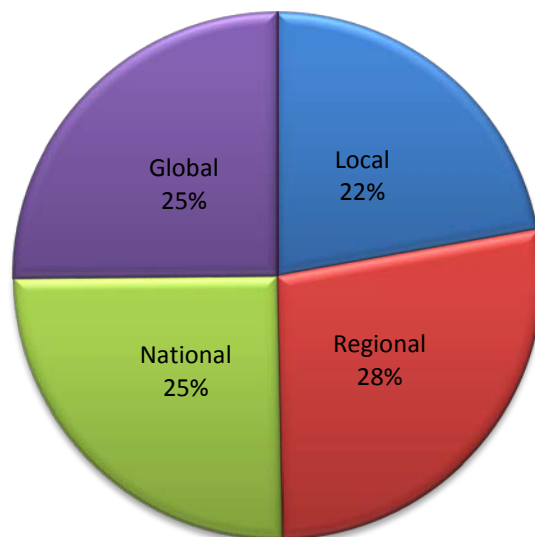


Figure 5. Q.5. What geographic scales of sea-level rise information are of interest to you? Multiple answers were allowed to this question, and the chart shows: a) all the responses, b) responses from non-researchers identified in Question 2.

This distribution in spatial interest is very similar for each group of respondents. The emphasis of ice2sea is on contributions to global sea-level rise, and there is minimal study within ice2sea of the oceanographic circulation and hence the local and regional affects.

Lesson #11 for ice2sea communications. These responses show that all spatial scales are significant to our stakeholders, and to the extent that it is possible, ice2sea communications need to reflect the local to global picture.

The last question on the use of sea-level rise projections asked what impacts were of interest or relevance. Multiple answers (Figure 6) were allowed out of 7 options. Although the responses were fairly uniform, there was higher interest in average sea-level rise and flood risk from storm-surges. It does however show that our stakeholders have a broad interest in the consequences of sea-level rise.

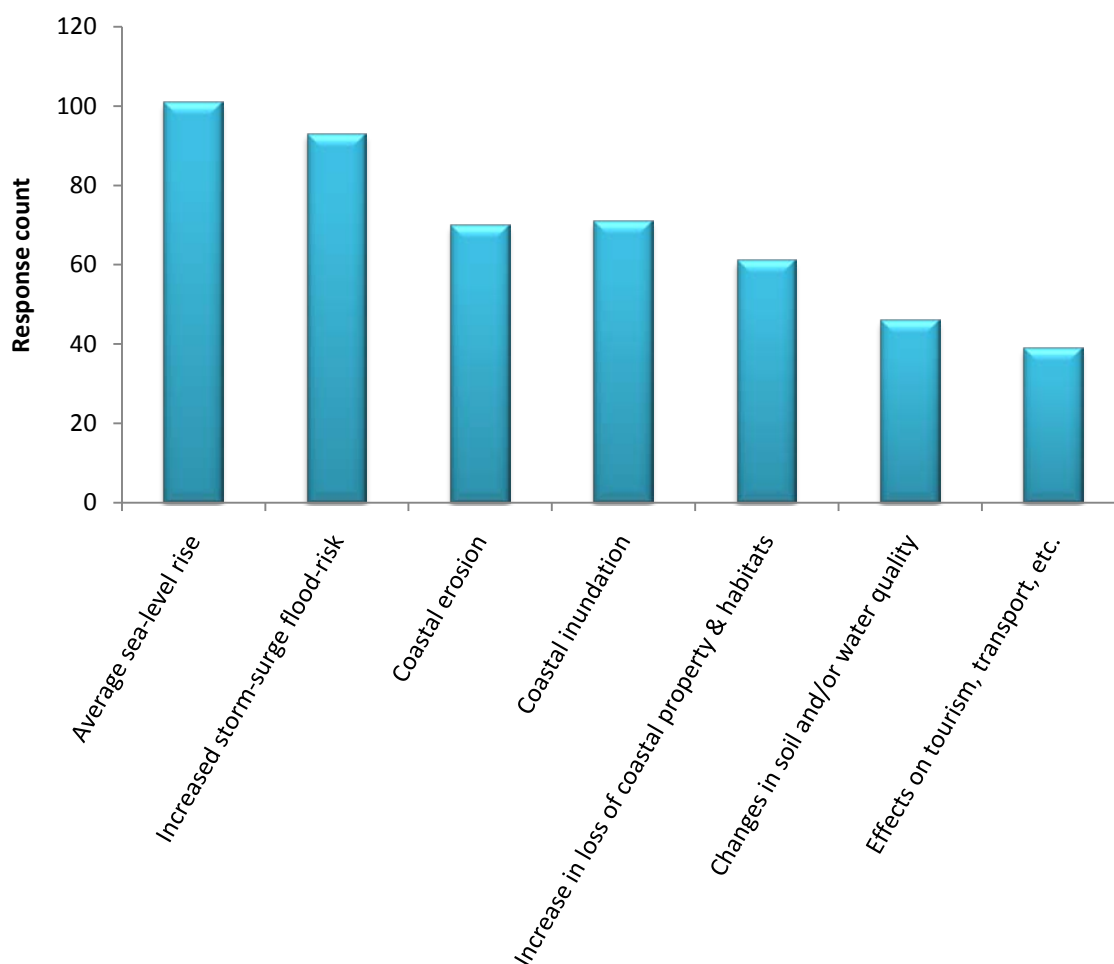


Figure 6. Q.6. Which of the following seven impacts are of interest/relevance to you? Multiple answers were allowed to this question, and the chart shows all the responses.

Further breakdown of the responses to this question given non-researchers is given in Figure 7 below. There were in addition a total of 12 respondents chose to make “other comments”. Several highlighted the importance of the consequences of sea-level rise resulting in the displacement of people living in coastal areas, and the impacts of large scale population movements - leading to possible increased geo-political tensions. Where this might not be practical or economic in poorer regions, there could, of course, be loss of life. Others were concerned about the effects on wetlands, and marine species, including the loss of habitats and biodiversity. Such habitats often occur in areas surrounding river mouths, particularly in deltas, which are often subject to both sea-level rise, and increased river flooding. Three further comments in the “other” category were not actually impacts, (e.g. “regional variation in sea-level rise”). One respondent noted that detailed mapping of sea-level rise is important as “averages are of little value as they can be easily contradicted by sceptics at the local level.”

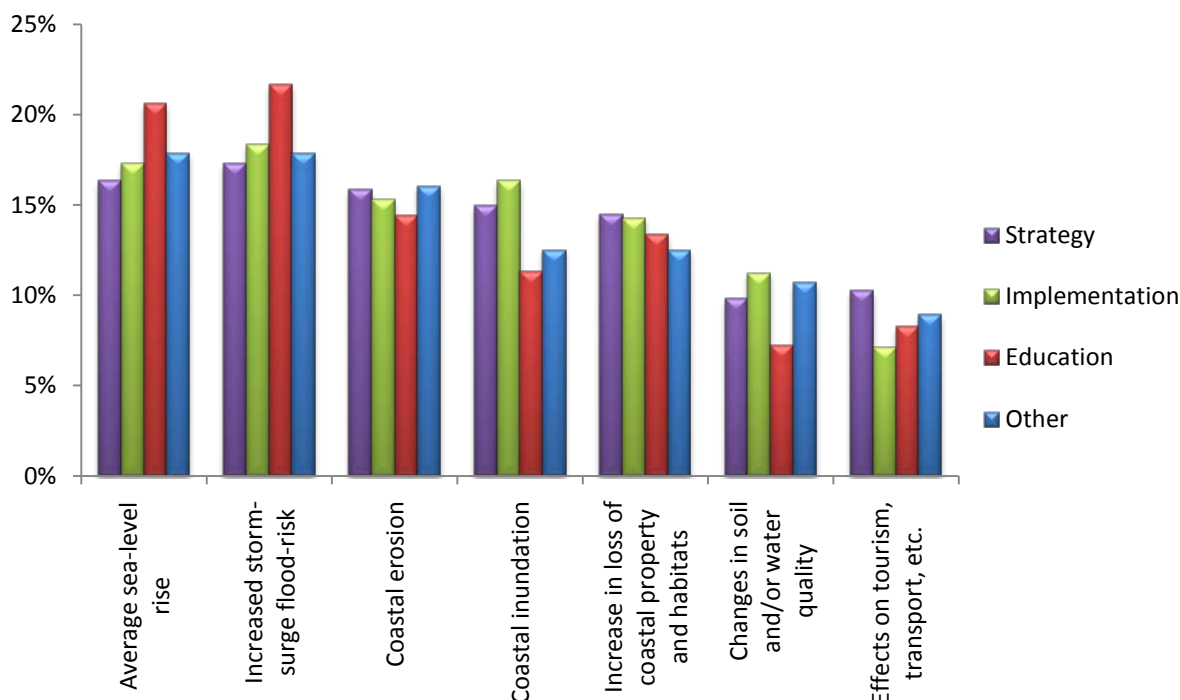


Figure 7. Q.6. Which of the following seven impacts are of interest/relevance to you? Multiple answers were allowed to this question, and the chart shows breakdown by type of respondent interest (to Question 2).

The most obvious feature of Figure 7 is the overall similarity in response from the different types of area of interest. With the slight exception (by only 3%) were those that work in education, who were more interested in the average sea-level rise and increases in storm surges, with less interest in soil and water quality.

Lesson #12 for ice2sea communications. There is a wide interest in the impacts of sea-level rise across the areas of interest declared by stakeholders. A broad approach to communication is required in this regard, and a specific emphasis on particular impacts to particular stakeholders is not justified.

7.4. Risk, Probability, and Uncertainty

The third group of questions was aimed at determining how various groups of stakeholders' understand risk and their requirements for information in the areas of risk, probability, and scientific uncertainties. To assist in the explanation of ice2sea science and improve understanding of the probability of sea-level rise projections, we first wanted to assess the level of understanding of probability. The responses to Question 7 from all the respondents are shown in Figure 8 below.

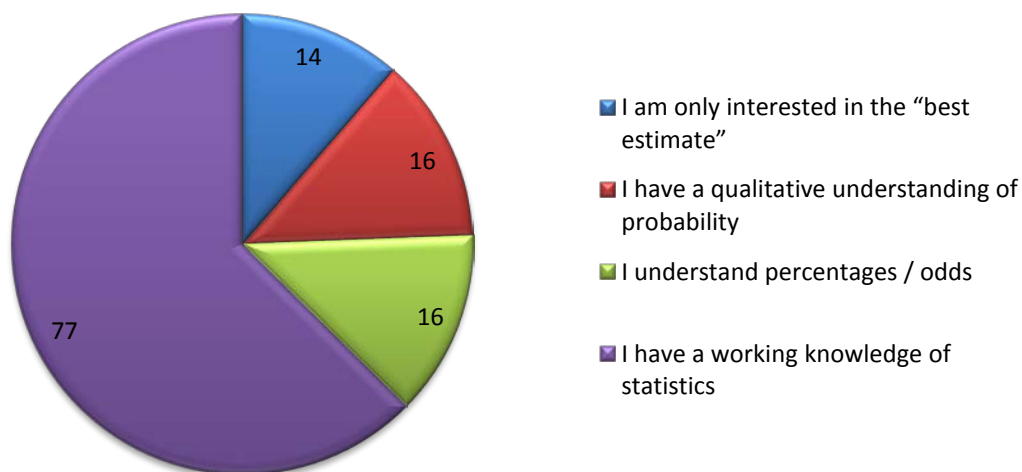


Figure 8. Q.7. Which of the following best describes your understanding of probability? Only one answer was allowed to this question. The chart shows the responses of all respondents.

Care must be taken with these results, as this is only the respondents' own assessment of their understanding and ability, and some respondents may well have an inflated impression of their level of understanding, and indeed others may have underestimated it. It might be interesting to take this further and conduct a quantitative test of the understanding of probability of each group, but this is beyond the scope of ice2sea and the stakeholder review.

Of course, with a large number of researchers responding to the questionnaire, one would expect the majority to have a working knowledge of statistics and probability. Therefore, for Figure 9, the answers for those not involved in research are shown. For each type of respondent, approximately half say they have a working knowledge of statistics, so it is worth including probabilities in all communications where applicable, but also giving either explanations or summaries. This is particularly true of those involved in implementation of sea-level rise data, where a quarter simply require a best estimate figure.

Lesson #13 for ice2sea communications. Half of ice2sea stakeholders claim to have a working knowledge of statistics which suggests that communications should not implicitly underestimate the skill of stakeholders in interpreting statistical representations. However there are sufficient significant numbers of stakeholders involved in strategy and implementation of sea-level rise projections who want a simple best estimate, and along with an explanation of probabilities, a headline figure should also be included.

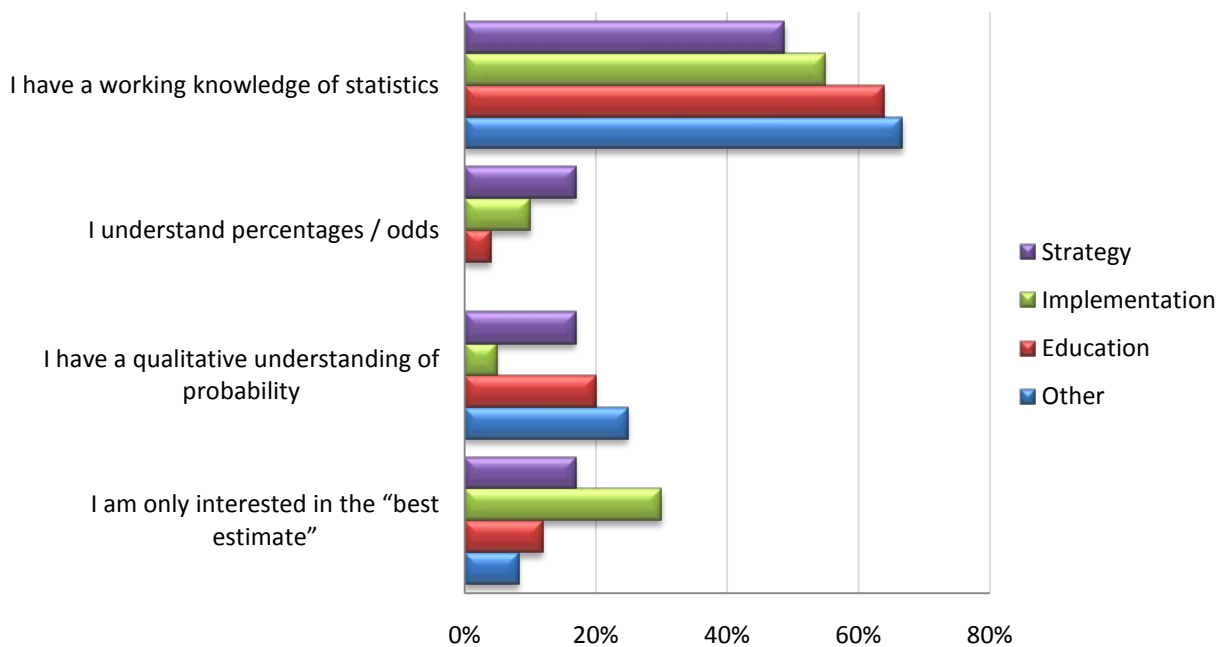


Figure 9. Q.7. Which of the following best describes your understanding of probability? Only one answer was allowed to this question. Non-researcher categories were identified in Question 2.

When asked how they would like to see data presented (Figure 10), there was a fairly even distribution across the various types of presentations. This is not particularly helpful in suggesting how to best present ice2sea results, and therefore seems likely that a variety of presentation methods will be required.

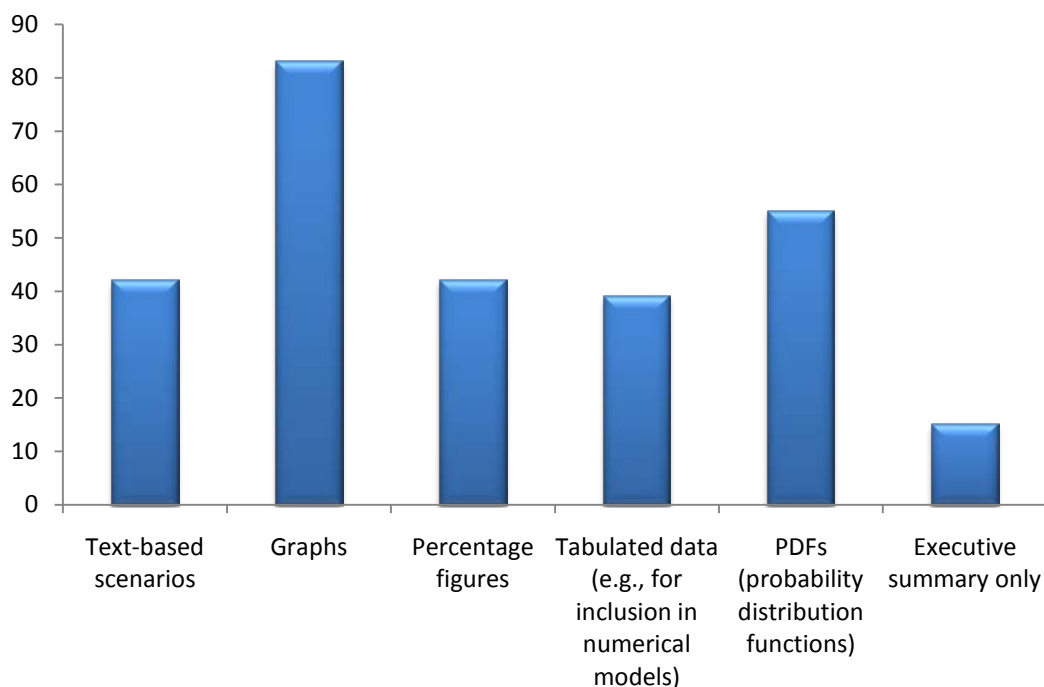


Figure 10. Q.8. How would you prefer to see results on probability and risk presented? Multiple answers were allowed for this question, and the chart shows all responses.

Removing the non-researchers, and breaking the responses to this question down to type of respondent (Figure 11), again from their answer to Question 2 shows, as expected, less emphasis on graphs, though these are still the preferred methods of communicating results across all stakeholder groups. Perhaps surprisingly the strategy group do not prefer short “executive” summaries – as we had been led to believe by those involved in communications with policy makers. This may results from the fact that this group tend to have pressing schedules and wide interests, and so can rarely devote sufficient time to thorough reading of reports.

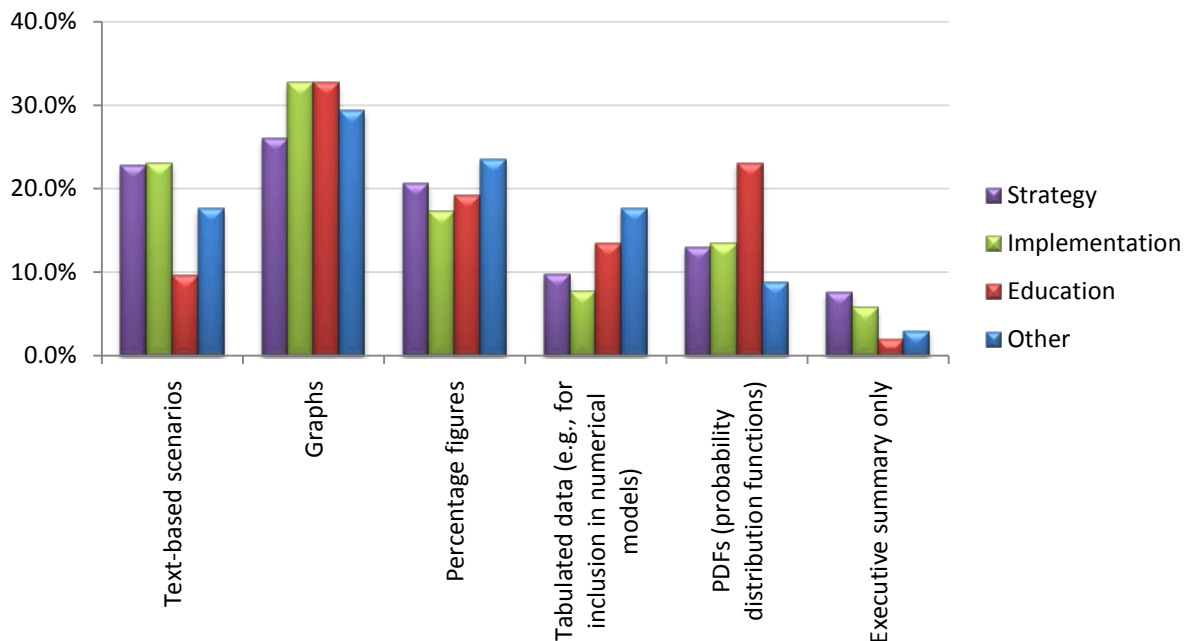


Figure 11. Q.8. How would you prefer to see results on probability and risk presented? Multiple answers were allowed for this question, and the chart shows all responses except researchers

Lesson #14 for ice2sea communications. All groups of stakeholders wish to see results presented graphically. Even policy makers are not interested just in an executive summary.

Question 9 was aimed at determining the level to which stakeholders are interested in low-likelihood, high-impact projections. It reflects the difficulty presented to scientists in ruling out complete, rather implausible rates of sea-level rise. Responses to this question are shown in (Figure 12), which shows a surprisingly high interest in low-likelihood events. More than one of respondents (that expressed an opinion) claimed to be interested in events that have less than a 1% chance (1 in 100 likelihood) of occurring, and around a quarter claimed interests in events that might have only a 0.1% (1 in 1000) likelihood.

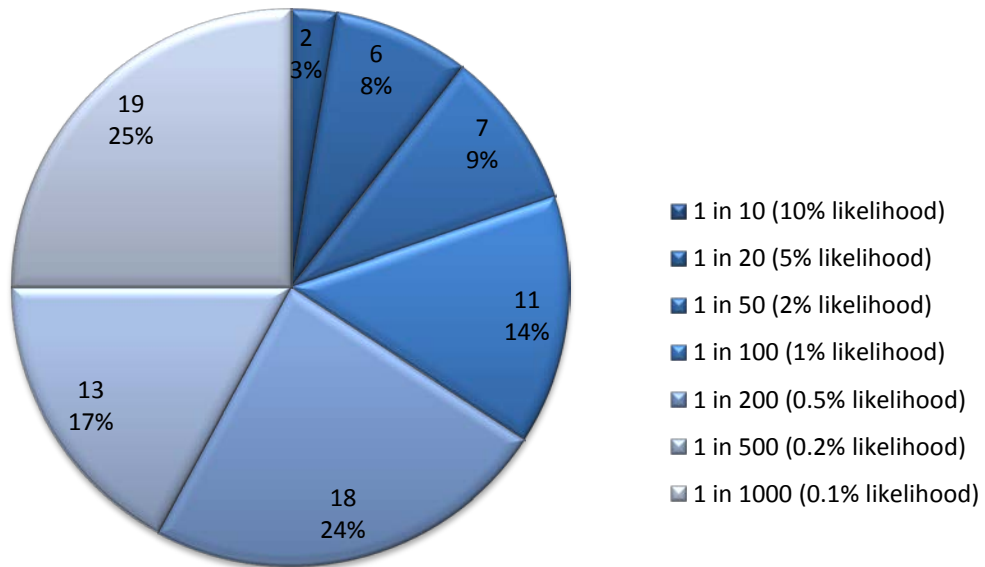


Figure 12. Q.9. When is an event related to sea-level rise so unlikely that it ceases to be relevant to you? Only one answer was allowed to this question. The chart includes all responses to the question, but, in addition, 27 respondents said that they were unsure and those responses are not included in the figure.

Figure 13 below shows these responses for only “non-researchers”. Although here there is more variation in the main interest probability of each group, it is clear that the majority of all types of stakeholders are interested in surprisingly low-likelihood events (1 in 500 to 1 in 1000) (see Lesson #3).

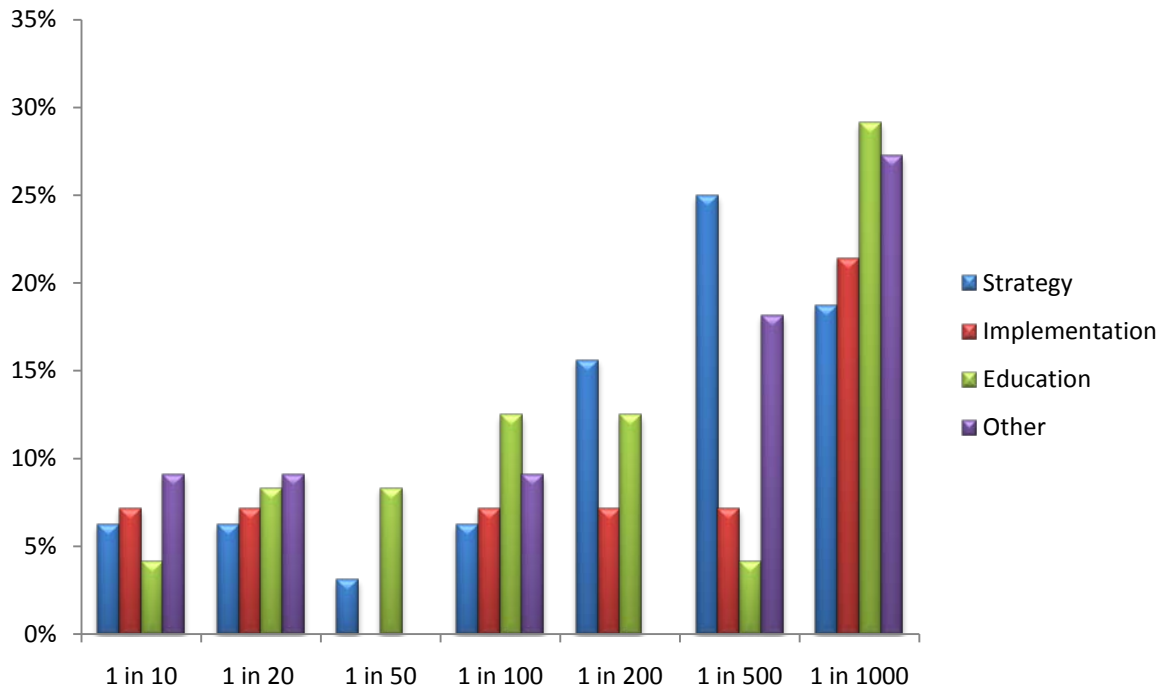


Figure 13. Q.9. When is an event related to sea-level rise so unlikely that it ceases to be relevant to you? Only one answer was allowed to this question. The chart shows responses by category of respondent excluding those responding “unsure”.

Here we also thought it interesting to find out which respondents were interested in the very low-likelihood events. Figure 14, was produced using only those that responded 0.2% and 0.1% to Question 9, with cross-referencing to Question 3, that explored the contexts in which respondents use sea-level rise projections.

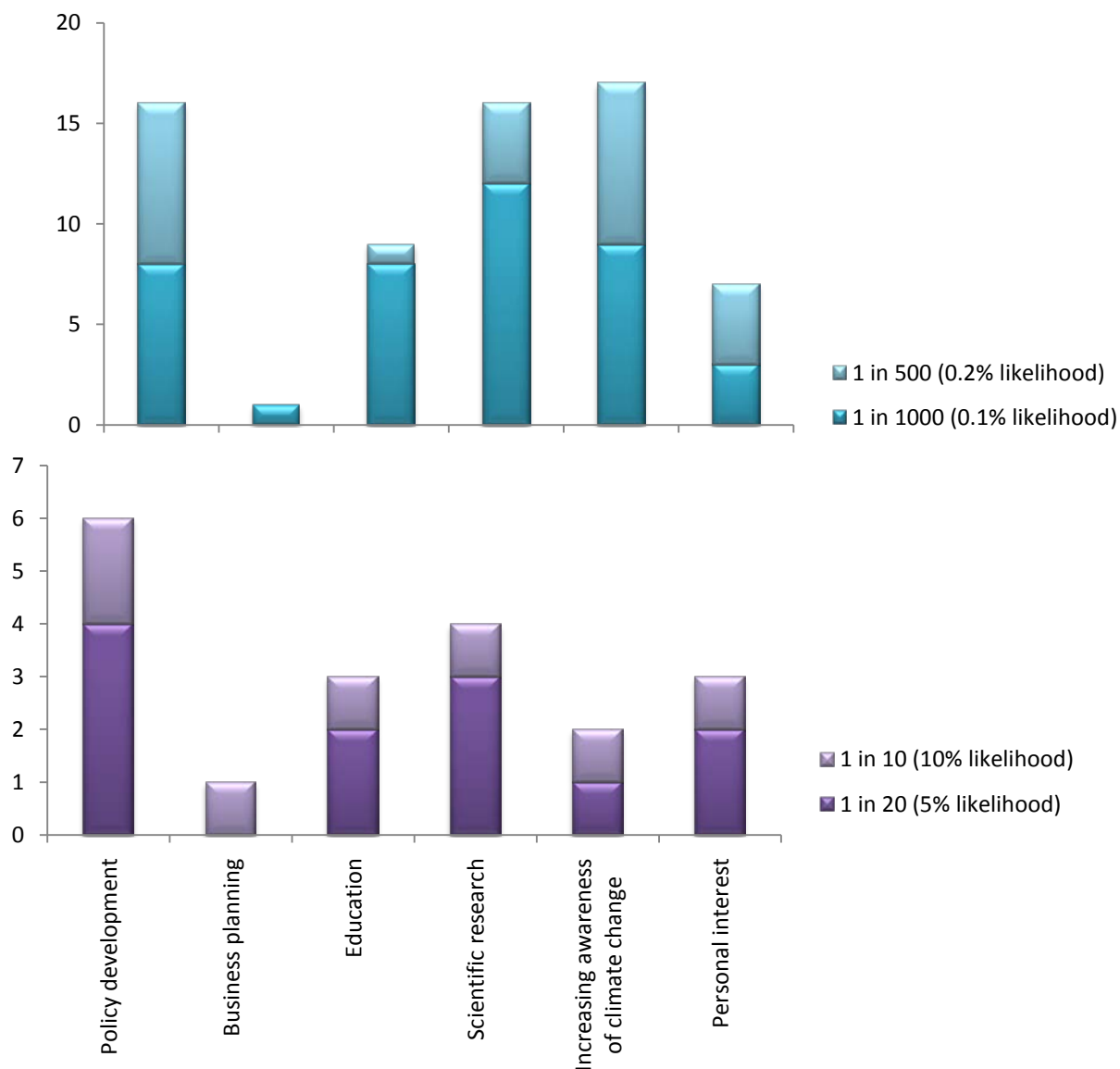


Figure 14. The contexts of use of SLR projections of those who are interested in: Top, turquoise: low likelihood events (0.1% or 0.2%); bottom, purple: high likelihood events (5% or 10%).

It might have been expected that it would be predominately the “researchers” that were interested in the low-likelihood events, but Figure 14 shows that there is actually a roughly equal proportion of “policy makers” who are interested also interested in this category of events. As expected, “business planners” are not so interested in low-likelihood events.

The last question we asked in this section was aimed at exploring understanding in both our stakeholders’ understanding of uncertainty in measurements, and their requirements for this information. The results to this question are shown in Figure 15.

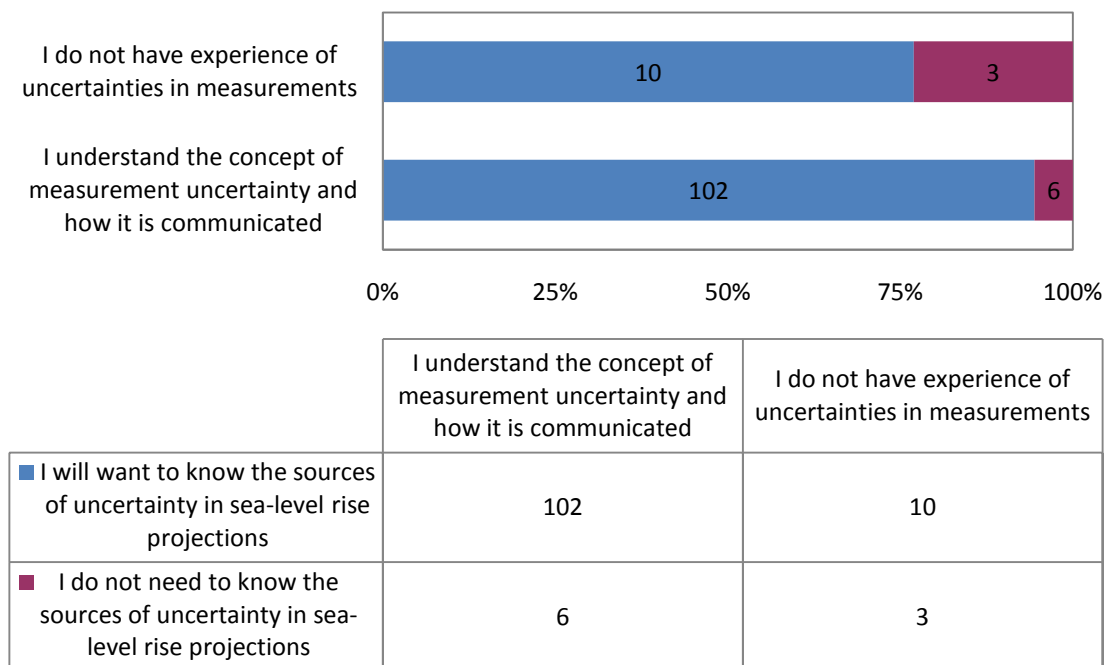


Figure 15. Q.10. Which of the following combinations best describe your understanding and use of uncertainty? Only one of the four boxes could be selected. The responses of all respondents are shown in the chart.

It is clear from this that the majority of respondents declare that they both understand uncertainty, and want to know where uncertainties in measurements/models arises. However, as for Question 7 on their understanding of probability, the responses reflect only respondents own determination of their knowledge, and although further study of this would be interesting, it is beyond the scope of this project.

Lesson #15 for ice2sea communications. Ice2sea stakeholders on the whole (85%) say they understand measurement uncertainty and the way it is communicated. They declare an interest in the sources of uncertainty in projections, and so this should be incorporated into ice2sea communications.

7.5. Delivery of sea-level rise projections

The final section of the questionnaire (apart from a short section on follow-up actions) was designed to investigate how stakeholders would prefer to see ice2sea information presented. Question 11 asked how they would prefer to see results on probability and risk presented and to categorise their opinion of importance for each media (Figure 16). Clear opinions were expressed on the relative importance of the use of websites, published articles, and science journals. It is also clear that glossy brochures are not considered useful. Perhaps however, we would have had a different answer if we had not included the word “glossy” – wording of questions is important to interpretation.

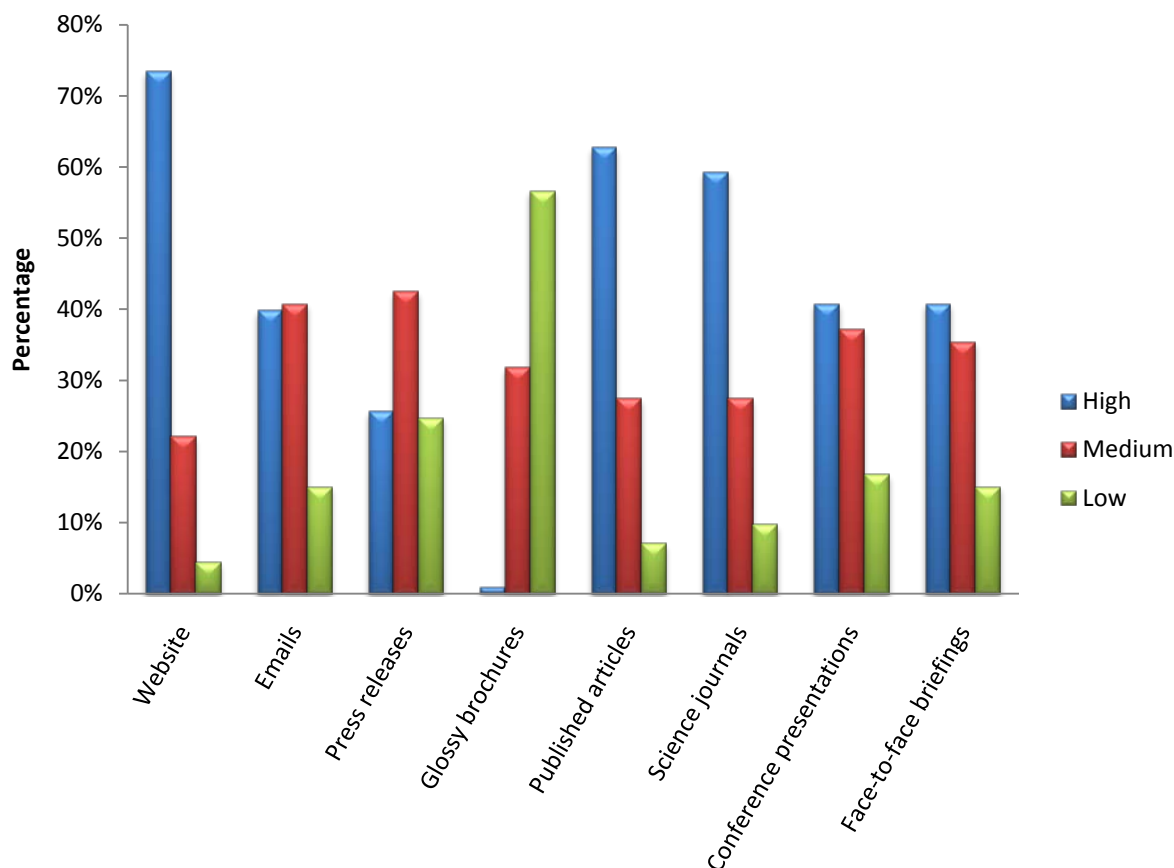


Figure 16. Q.11. How would you prefer to see results on probability and risk presented? Respondents were asked to choose from high/medium/low for each route of presentation. Chart shows responses from all respondents.

Lesson #16 for ice2sea communications. The clear importance of the website as a communication tool has been highlighted. For this reason, the ice2sea website, www.ice2sea.eu, should be professionally redeveloped, to give a better design feel, and easier to access content. Ice2sea science journal papers, and other published articles, should be easily accessible through the website.

There were a considerable number of addition comments added to the responses to this question. One such comment highlighted the importance of outreach to the general public²². Other respondents commented on the need to engage with the media, through preparation of briefing material to publicise results, and to

²² This is a topic that has been given consideration by the ice2sea Steering Committee, with discussions on how far to take such activities. Considerable funds could be spent on a full outreach activity, which would engage with school groups, provide learning tools through various multimedia techniques, as well as provide a dissemination route to the broader public on cryospheric science in general. However, this was felt beyond the scope of the project, and for this to be effective, sufficient financial and personnel resources would be required. We feel our priority target audience are the policy makers, their advisors, and administrators. For this reason, Our public outreach activities will consist of: Press releases on important activities and science results; A glossary of terms on the website related to all aspects of ice2sea, to enable fuller understanding of ice2sea results; Photographs, diagrams, and videos on the website, to set the context of the work.

minimise misinterpretation of key facts, and also through television and radio interviews, where appropriate²³. One suggested these could be given by music or movie stars; through PBS/NOVA presentations; college presentations; Nature shows; Discovery Channel; Animal Planet shows; Whale Wars etc.²⁴ Another respondent suggested an RSS feed²⁵.

Responses to an earlier question implied a brochure might be the best way to get information across to busy policy makers, but responses to Question 12 (Figure 17) gave a slightly different picture, which may require further investigation before the end of the ice2sea project²⁶.

When asked whether they wanted all information on sea-level rise projections to be from a peer-reviewed source (Question 12), of the total respondents, 39% said they did not, while 61% said that they do, but this information might be better interpreted in the light of the categories of respondents. For this reason, Figure 17 shows how respondents answered Question 12 depending on how they answered Questions 2 (left) and 3 (right).

²³ *These are all areas the Co-ordinator is actively involved, and will be used when applicable for ice2sea results and activities.*

²⁴ *The CoastAdapt project (www.coastadapt.org) will provide a one-stop information resource including examples of best practice, tools and resources aimed at local coastal communities and local government in the Northern Periphery Programme area (www.northernperiphery.eu).*

²⁵ *This has been considered, along with social networking sites, by the Programme Office. Certainly for the earlier stages of the project, these were not felt appropriate due to insufficient new and widely interesting information to disseminate. Unless these features are used very regularly, they can counter-productive, if it appears we have little to say, whilst analysis is being completed. We are however aware of these facilities, and will use them should it become apparent or advised that this is the best course of action for ice2sea.*

²⁶ *Currently, ice2sea has information leaflets, which are simply publicity about the project, but the plans are to create a full brochure of the final results of the ice2sea, towards the end of the project funding period. Who this is aimed at, and who it is sent to need to be considered.*

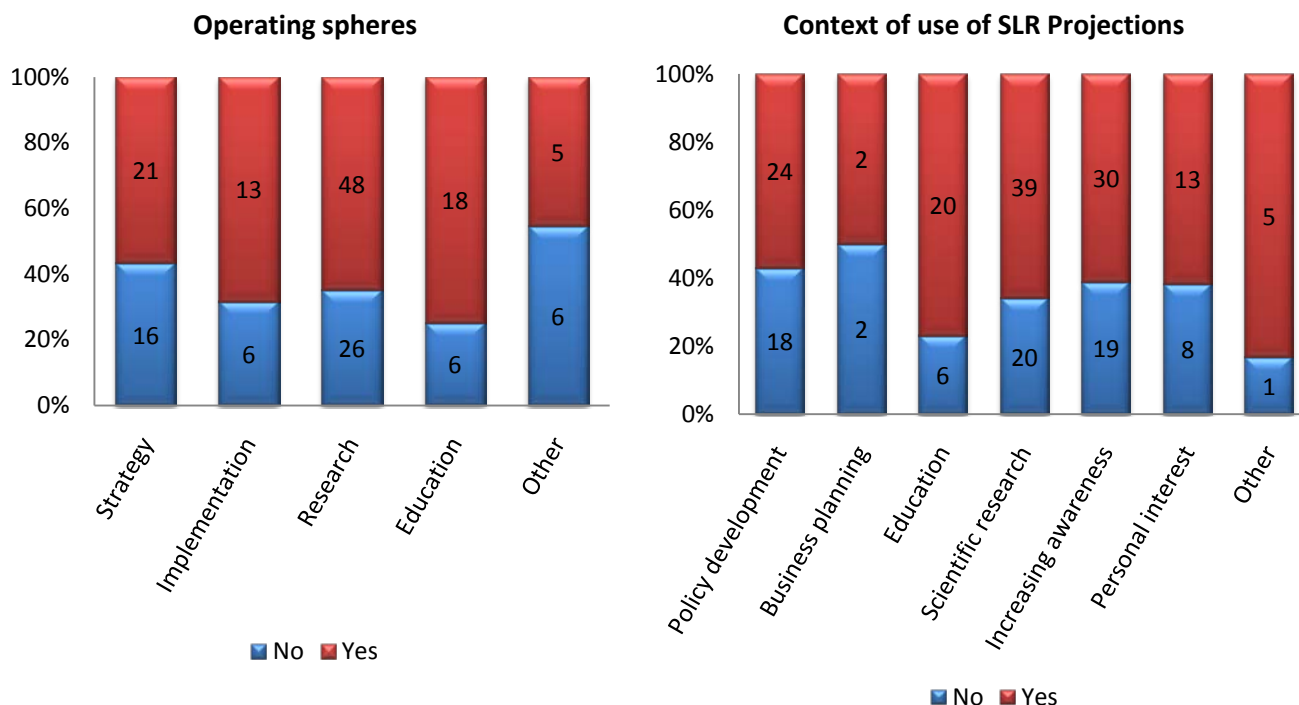


Figure 17. Q.12. Do you require all information on sea-level rise projections to be from a peer-reviewed source? Left: categorised according to answer given to Q.2. (“Which spheres do you consider that you operate in?”) Right: categorised according to answer given answer to Q.3. (“In which context do you use sea-level rise projections?”). Proportion percentage yes/no shown in colour, with the number of respondents given in each category.

For the last question we asked when people wanted to be informed of updates or information on the project’s progress (Figure 18).

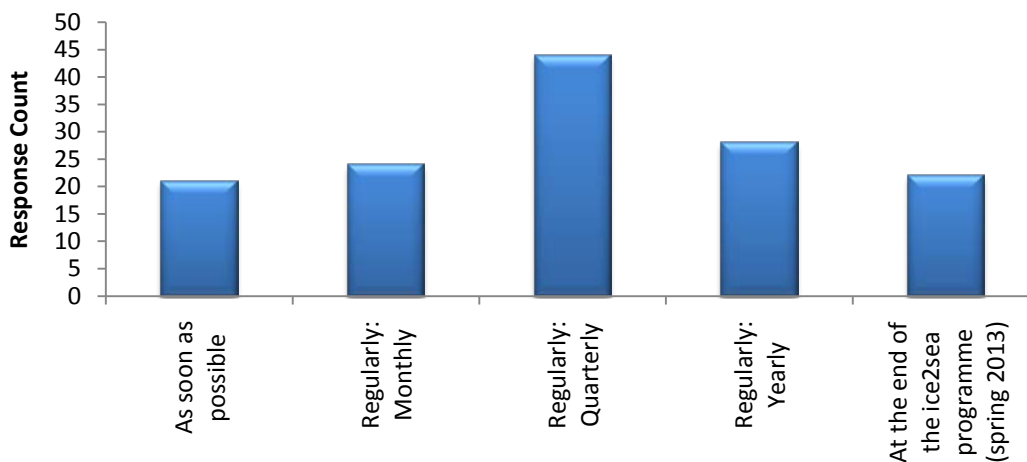


Figure 18. Q.13. When do you want information or updates? Multiple answers were allowed for this question. The chart shows all responses.

Lesson #17 for ice2sea communications. We should consider establishing some regular contact with stakeholders to keep them informed of developments, and alert them to upcoming information.



7.6. Summary of Stakeholder Questionnaire

The results of the ice2sa Stakeholder Questionnaire will assist in the formulation of the strategy for communication of the final results of ice2sea, and projections of sea-level rise, although the low number of responses in some categories was not sufficient to undertake all of the analyses that were originally conceived. Specific lessons for ice2sea communications have been highlighted above, but it is undoubtedly clear that there is no single solution that will satisfy all categories of stakeholders, and that an approach that presents information on multiple timescales, geographical-scales and with several treatments of risk and uncertainty will be required to satisfy the stakeholder community.



8. Concluding remarks

The communications of results from scientific projects in sensitive areas of the debate surrounding climate change, such as that addressed in ice2sea, requires planning and thought. There are few sources of guidance on best practice, and whilst scientists and science managers may believe that adequate communications can be achieved in an ad hoc fashion, this probably not the case for a programme of the size and scale of ice2sea.

The ice2sea Stakeholder Review has been used to identify specific lessons (Appendix F) that should guide formulation of the final communications of the project. Some of these lessons learned here may appear self-evident, but there are many examples of where these apparently simple lessons have previously been ignored, and therefore the clarity and effectiveness of communications degraded. In the arena of sea-level rise, in which explicit and implicit decisions with identifiable impacts on communities and individuals are already being made, there is a clear requirement for the results of even rather academic studies to be communicated with greater care and sensitivity than exercised to date by many researchers.

Given the resources allocated to this activity, the ice2sea Stakeholder Review has been focussed rather heavily, although by no means exclusively, on British stakeholders. And while care has been taken to draw general lessons from the exercise that are widely applicable, it is clear that the requirements of national and sub-national level stakeholders will be strongly influenced by factors such as national legislation and commercial markets. It is thus desirable that the ice2sea communications are formulated without reference to such national issues, but with a pan-European perspective.

The ice2sea Stakeholder Review does identify the specific requirements of certain categories of stakeholder, but more clearly it highlights the diversity of their requirements, covering ranges of timescales, geographical scales, and approaches to communication of risk and uncertainty. Ice2sea will need to provide a variety of approaches to satisfy these varying needs. In particular, it should not be overlooked that a substantial fraction of those that identified themselves as “stakeholders” are actually researchers and academics.

Ice2sea’s activities related to final delivery in the policy-making audience (WP6.5) should be planned on the basis of the lessons learned during the Stakeholder Review, and include the activities identified for that workpackage. However, it would be valuable to review the communications strategy for this phase of the programme in the light of these lessons. In particular, given the difficulties encountered during the Stakeholder Questionnaire, a greater emphasis on face-to-face briefings for key policy-makers may be a more effective communication route.



Appendix A – Specification of the Stakeholder Review

The Stakeholder Review was specified in two sections of the ice2sea Description of Work:

Concept – Uncertainty

Pages 10-11.

...The experience with The UK Environment Agency described above, indicates that a clear review of the stakeholder requirement would allow better targeting and communication of the results of the ice2sea programme. With this in mind, in the early stages of the programme, the ice2sea programme office will undertake a detailed stakeholder review. This exercise must begin with identification of the stakeholders and points-of-contact. Which will include:

- *Specific parts of the European Commission and other European policy-making instruments with an interest in climate-change and sea-level projections*
- *The advisory bodies supporting those policy-makers (e.g. European Environment Agency)*
- *European national governments and their advisors (e.g. Network of the Heads of Environment Protection Agencies)*
- *International policy-making bodies (e.g. United Nations Environment Program)*
- *Bodies with an interest in sustainable coastal management (e.g. EuroSION)*
- *Academic and commercial organisations engaged in economic projection of coastal change impacts (e.g. commercial insurers and re-insurers).*

Once a database of stakeholders is identified, the stakeholder review will then proceed with an assessment of needs, especially with regards to timescales of projection and uncertainty analysis. The results of this stakeholder review will be used to guide the delivery in the latter stages of the programme.

Description of W1.2: Stakeholder Review

Pages 39-40

Objectives:

- *Identify the best methods of describing the sealevel projections and risks within particular communities of stakeholders within the EU.*
- *Understand the barriers and limits to the effective communication of uncertainty to communities of stakeholders within the EU.*
- *To maximise the benefits of all ice2sea research to all stakeholders by providing a more thorough understanding of their needs.*

Description of work

Background: *Recent experience indicates that different stakeholder groups have rather different requirements when it comes to the use of sea-level rise projections and understanding. For example, sea-defence planners have specific interests in rates of sea-level rise, while policymakers engaged in negotiating greenhouse gas emissions controls are more focused on a long-term commitment to sea-level rise that could arise if particular cryospheric thresholds are exceeded especially where these thresholds can be said to have been exceeded as a result of human interference. Essentially, an insight into the questions which various stakeholders require answering is urgently required and has not yet been collected.*



In support of achieving the correct framing within the delivery elements of the ice2sea programme (W6.1 & W6.3) we will undertake a stakeholder review, to determine what are the most pressing questions in each stakeholder area, and which scientific approaches can deliver them. The exercise will also reveal the level to which complex description of uncertainties can be understood and usefully incorporated into stakeholder activities. For example, the degree to which probability density functions are understood, and considered useful within the stakeholder community.

Specific tasks:

- *Develop form of review questionnaire to extract form and content of sealevel rise information required by policy-makers, sea-defence planners.*
- *Search for lists of stakeholders (~20²⁷) within EU and overseas.*
- *Draft questionnaire to investigate stakeholders opinions, follow-up by phone/email*
- *Compile results and assemble*
- *Publication of results (target journal – Climate Policy, or Climatic Change)*

²⁷ *In undertaking this activity, we found that this estimate of the number of stakeholders required for us to generate a coherent view of their opinion was significantly too low. In part, the significantly increased number of stakeholders covered by the questionnaire explains the delay experienced in delivering this workpackage.*



Appendix B - ice2sea meets the insurers

The following is an edited précis of discussions that took place on, Wednesday, September 30, 2009, between Ice2sea (David Vaughan and Elaina Ford) and Willis Research Network (Rowan Douglas and Matthew Foote).

The aim of the discussion was to explore the potential and actual utility of sea-level rise projections within parts of the insurance industry within the context of the ice2sea stakeholder review²⁸.

Rowan Douglas is the Chairman, and **Matthew Foote**, Research Director, of the Willis Research Network, which is part of the Willis Group Limited, a global insurance and reinsurance broker, WRN is headquartered in London and is one of only three major risk management and insurance intermediaries that operate on a worldwide basis.

Ice2sea: How would you summarise the role of Willis Research Network within the insurance industry?

Willis: The role of the Willis Research Network is largely related to the re-insurance industry. Re-insurers take on risk to protect insurers against extreme events. Our fundamental role is to keep maximum sustainable losses from reoccurring more than once in 200 – 250 years which is the level required by regulation.

In recent years, a whole sub-industry, focussed on catastrophic risk modelling, has grown out of this requirement – WRN is a leader in this area.

The fact that this analysis is focused on the high-impact / low-likelihood scenarios means we are always working in areas where statistical data is sparse. This has led to an engagement with public science, and attempts to understand the mechanisms and probabilities of extreme events.

Willis Research Network works with academia supporting open research and publishing, the development of new risk models and applications, and an active programme of meetings and collaboration. We also provide fellowships to fund researchers in collaborating universities and institutes. Our aim is to provide an open forum for the development of the science and the WRN actively works with insurers, reinsurers, catastrophe modelling companies, government research institutions and non-governmental organisations.

Ice2sea: Given that ice2sea is engaged in producing sea-level rise projections one 100-year and 200-year timescales, will these be of direct value or minor interest to the insurance industry?

Willis: The problem with seeing a direct value of ice2sea sea-level projections within the area of interest for WRN, or indeed, the insurance industry in general, is one of timescales. Because in the insurance/re-insurance industry, contracts are usually negotiated annually, the operational planning timescale we use is generally 3-5 years. We do consider strategic timescales of 10 – 20 years, but the setting of premiums is done on far shorter timescale and so does not directly benefit from a longer look at changing risk.

It is, however, interesting that our recent work with Global Climate Models has been beneficial, but perhaps not from the perspective you might expect. The value of these models and their output has been in what they have revealed to us about the statistics of extreme events within the current climate. So rather than being significant predictions of change, they are valuable in establishing current levels of risk.

²⁸ The account given here is taken from longhand notes made at the time of discussions; it is not a transcript of those discussions.



Ice2sea: A primary outcome of ice2sea will be better understanding of likely global sea-level rise rates: how does this compare with the regional scales that companies and governments work on?

Willis: Obviously, a sea-level rise in the middle of the North Atlantic is not significant issue for insurers.

We would certainly like to see good projections of global sea-level rise, and good science in general, lead to a more rational debate concerning climate change – but in that respect our response is similar to everyone else.

Perhaps, the most significant contribution that will come about for insurers from efforts like ice2sea, will be when eventually global sea-level projections are realistically localized, and integrated with regional climate projections to give input to regional planning and management strategies. However, from the point of view of global sea-level rise, the reaction of the insurance industry is not just to consider the likely impact on coastal assets, but on other potential sources of risk. For example, a major focus is in prediction the consequential impacts of storm surges. Recently, we have seen reports that sea-level rise might be connected to changing likelihood of volcanic eruptions, earthquakes and changes in ocean circulations. These certainly do make insurers prick up their ears, but there are real questions as to whether these are more than just fanciful hypotheses!

Ice2sea: So it sounds like the major impact on the insurance industry of reduced uncertainty in long-term sea-level rise projections will come about indirectly through the legislation and regulation that is employed by governments on the basis of those projections.

Willis: Unlike most industrialized countries, in the UK we traditionally insure against flood risk. There is a widely-discussed ‘Gentlemen’s Agreement’²⁹, between government and the insurance industry that makes this possible. It may not be written down with quite such clarity, but the essence is that insurers provide domestic flood insurance to all, so long as the UK government provides adequate flood defence. We take the definition of “adequate” to be a risk of defences being breached of less than once in 75 years.

Recent flood events, mostly riverine rather than coastal, have questioned whether such protection is now being maintained. At the moment it is not clear if the frequency of such events is changing or whether there has been an unfortunate coincidence of large events. However, it is clear that the future provision of flood risk insurance thus clearly depends on an interaction between the industry and the government, either through agreement, regulation, or taxation. The likelihood is that for the foreseeable future, insurance cover for flood risk will continue to be commercially available to almost all homes in UK – it is the cost of such cover that is in question.

One change that might occur is the legislation for the setting up of “catastrophe pools”, to which insurers might have to contribute, but which would provide a cash injections to support payouts in response to catastrophic events.

²⁹ More information is available on this rather formal and explicit agreement. For example: Huber, M. (2004), *Reforming the UK Flood Insurance Regime - the Breakdown of a Gentlemen's Agreement*, Centre for Analysis of Risk and Regulation, London School of Economics and Political Science, London, UK.

Appendix C – Stakeholder Questionnaire background

Ice2sea Stakeholder Review



www.surveymonkey.com/s/ice2sea

Sea-level rise

Fifteen EU countries have substantial coastlines that will be affected by global sea-level rise. Within these coastal regions

- * economic assets within 500 metres of the sea have an estimated value between €500 and €1,000 billion;
- * 47,500 km² of sites within 500 m of the coastline are identified as having high ecological value;
- * the population has more than doubled to 70 million people – currently 14% of the entire EU population.

In many of these coastal areas, future sea-level rise will increase rates of coastal erosion, accelerate the destruction of natural sea defences and increase the risk of coastal flooding. Developing policies to protect our coastlines, and reduce the impact on lives and livelihoods of EU citizens demand the best projections of sea-level rise available.

Overview

Ice2sea is a collaborative research programme involving 24 institutional partners. Ice2sea is specifically focussed on the contribution to sea-level rise from loss of continental glaciers and ice sheets. These give rise to the largest part of the uncertainty in the projections.

The ice2sea programme receives funding from the European Commission through the Framework 7 Programme (FP7) and from the many national agencies funding the institutional partners. The programme will run for four years, (2009-2013) with a schedule designed to provide input to the next Intergovernmental Panel on Climate Change (IPCC) assessment of climate change and its impacts.

www.ice2sea.eu





Research themes

Ice2sea has twin goals of improving the science behind sea-level prediction, and of providing new sea-level projections based on the most up-to-date climate projections. These goals will be realised through:

- * targeted studies of key processes in mountain glaciers, ice caps, and in the polar ice sheets (Greenland and Antarctica);
- * improved satellite determinations of current changes in continental ice mass;
- * development of more reliable techniques for predicting the response of ice-sheets and glaciers to environmental change;
- * delivery of comprehensive projections of the contribution of continental ice to sea-level rise over the next 200 years.

We will deliver these results in forms accessible to scientists, policy-makers and the general public, and include clear presentations of the sources of uncertainty.

This stakeholder review is being undertaken to provide guidance to ice2sea scientists as to how best to tailor the delivery of sea-level projections to our stakeholders. This will ensure that ice2sea delivers the maximum value to spheres such as policy-development, coastal defence, land-use management, business, education, and research.

Ice2sea welcomes the views of anyone with a professional or personal interest in sea-level rise. The aim of this questionnaire is for us to determine how best to present our results and uncertainties.

www.surveymonkey.com/s/ice2sea

www.ice2sea.eu





Appendix D – Stakeholder Questionnaire

Below are the questions sent out to numerous potential stakeholders via an online questionnaire.

1. Ice2sea Stakeholder Questionnaire

The ice2sea stakeholder questionnaire is your opportunity to influence a major European research programme, and ensure that the delivery of sea-level rise projections is relevant and optimal for business and policy decisions as well as for society in general.

About the research programme:
Ice2sea is a four-year programme of scientific research funded by the EU Framework-7 programme. It draws expertise from scientists in 24 European and international universities and research institutes. It will produce 200-year projections of the contribution to global sea-level rise made by snow and ice, as well as an assessment of sea-level rise along European coastlines. The projections will incorporate estimates of probability and uncertainty.

Results from ice2sea will be included in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change due in 2013, and will be made available in a variety of accessible formats to policy-makers, business stakeholders, and the wider public. For more information on the project, see the [website](#).

This stakeholder review is being undertaken to provide guidance to ice2sea scientists as to how best to tailor the delivery of sea-level projections to our stakeholders. This will ensure that ice2sea delivers the maximum value to spheres such as policy-development, coastal defence, land-use management, business, education, and research.

Ice2sea welcomes the views of anyone with a professional or personal interest in sea-level rise. The aim of this questionnaire is for us to determine how best to present our results and uncertainties.

We expect this to take you no longer than 10 minutes to complete. Thank you for your time.

2. Who are you?

Please answer these questions so we can put your opinions in context.

*** 1. In which fields are you active?**

Public sector

Private sector

Academia

Charity

Other (please specify)

2. Which spheres do you consider that you operate in?

- Strategy
- Implementation
- Research
- Education
- Other (please specify)

***3. In which contexts do you use sea-level rise projections?**

- Policy development
- Business planning
- Education
- Scientific research
- Increasing awareness of climate change
- Personal interest
- Other (please specify)

3. Sea-level projections**4. How far into the future do you consider sea-level rise projections as being valuable?**

- 10 years
- 50 years
- 100 years
- 200 years
- 500 years
- Other (please specify)

5. What geographic scales of sea-level rise information are of interest to you?

- Local
- Regional
- National
- Global

6. Which of the following seven impacts are of interest/relevance to you?

- | | |
|---|--|
| <input type="checkbox"/> Average sea-level rise | <input type="checkbox"/> Increase in loss of coastal property and habitats |
| <input type="checkbox"/> Increased storm-surge flood-risk | <input type="checkbox"/> Changes in soil and/or water quality |
| <input type="checkbox"/> Coastal erosion | <input type="checkbox"/> Effects on tourism, transport, etc. |
| <input type="checkbox"/> Coastal inundation | |
| <input type="checkbox"/> Other (please specify) | |

4. Your understanding of probability and uncertainty
7. Which of the following best describes your understanding of probability?

- I am only interested in the "best estimate"
 I have a qualitative understanding of probability
 I understand percentages / odds
 I have a working knowledge of statistics

8. How would you prefer to see results on probability and risk presented?

- Text-based scenarios
 Graphs
 Percentage figures
 Tabulated data (e.g., for inclusion in numerical models)
 PDFs (probability distribution functions)
 Executive summary only

Other (please specify)

9. When is an event related to sea-level rise so unlikely that it ceases to be relevant to you?

- | | |
|--|---|
| <input type="radio"/> 1 in 10 (10% likelihood) | <input type="radio"/> 1 in 200 (0.5% likelihood) |
| <input type="radio"/> 1 in 20 (5% likelihood) | <input type="radio"/> 1 in 500 (0.2% likelihood) |
| <input type="radio"/> 1 in 50 (2% likelihood) | <input type="radio"/> 1 in 1000 (0.1% likelihood) |
| <input type="radio"/> 1 in 100 (1% likelihood) | <input type="radio"/> Don't know |

Additional comments?

10. Which of the following combinations best describe your understanding and use of uncertainty?

	I understand the concept of measurement uncertainty and how it is communicated	I do not have experience of uncertainties in measurements
I will want to know the sources of uncertainty in sea-level rise projections	<input type="radio"/>	<input type="radio"/>
I do not need to know the sources of uncertainty in sea-level rise projections	<input type="radio"/>	<input type="radio"/>

5. Delivery of sea-level rise projections
11. How useful to you are the following methods of information delivery?

	High	Medium	Low
Website	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Emails	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Press releases	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Glossy brochures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Published articles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science journals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conference presentations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Face-to-face briefings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Additional comments

12. Do you require all information on sea-level rise projections to be from a peer-reviewed source?
 Yes

 No

Comments

13. When do you want information or updates?

- As soon as possible
- Regularly: Monthly
- Regularly: Quarterly
- Regularly: Yearly
- At the end of the ice2sea programme (spring 2013)
- If you would like to be added to our mailing list, and receive ~fortnightly bulletins, please [click](#) here or add your email address below

6. Follow up**14. Would you be prepared for us to follow up this online survey by telephone or email?**

- Yes No

15. If yes, please give:

your contact

number:

your email address:

16. Please suggest details (preferably email address) of anyone else you know who might be interested in receiving this questionnaire

*** 17. Your details. Organisation and Country are required, so we can put your answers in context. If you include your name we will not contact you to complete the survey again. We will not pass your details on to any third party, and your responses will remain anonymous.**

Name:

Organisation*:

Country*:

Email Address:

Phone Number:

18. If you have any further comments, please add them here.

If you didn't understand, or answer, any of the questions, please tell us why.

Appendix E – Ice2sea Stakeholders

Below is a list of all those who completed the questionnaire and input some details of who they are, though note not everyone added their name. Categorisation was added by us. Some exited the survey before adding their details; however their answers that they have given have been included in the above analysis. Respondents are ordered by country.

Name:	Organisation*:	Country*:	Category
Darren Merritt		Australia	unknown/other
	Central Institute for Meteorology and Geodynamics, Vienna	Austria	research institutes
Shishir Shil	All-Party Parliamentary Group (APPG), Bangladesh Parliament	Bangladesh	politician
Didarally	ULB	Belgium	research institutes
	VUB	Belgium	research institutes
	VUB	Belgium	research institutes
	ULg	Belgium	research institutes
Frank Pattyn	Université Libre de Bruxelles	Belgium	research institutes
Peter Spry	BC Ministry of Transportation and Infrastructure	Canada	governmental advisor
Martin Sharp	University of Alberta	Canada	research institutes
Liu Qiao	Chinese Academy of Science	China	research institutes
Blaz Kurnik	EEA	Denmark	environmental agencies
Henning Thing	University of Copenhagen	Denmark	environmental agencies
Rene Forsberg	DTU-Space	Denmark	research institutes
	CIC	Denmark	unknown/other
Oliver Colvile	MP	England	politician
Ted Edwards	Canterbury City Council	England	politician
Marti Tipper	NNDC [North Norfolk District Council]	England	governmental advisor
Caroline Dinenage	MP for Gosport	England	politician
G.Henderson	Suffolk Coast Against Retreat SCAR	England	environmental agencies
Lars Muller	European Commission DG CLIMATE	EU	environmental agencies
Laura Höijer	Finnish Ministry of the Environment	Finland	environmental agencies
Mikko Peltonen	Ministry of Agriculture and Forestry	Finland	governmental advisor
Thomas Zwinger	CSC	Finland	research institutes
	Université Joseph Fourier	France	research institutes
Sébastien Laurier	compagnie soleil bleu	France	unknown/other
Baille Francois	ATOS ORIGIN	France	unknown/other
Olaf Eisen	AWI	Germany	research institutes
Alex Robinson	Potsdam Institute for Climate Impact Research	Germany	research institutes
Anders Levermann	Potsdam Institute for Climate Impact Research	Germany	research institutes
Hartmut Hellmer	AWI	Germany	research institutes
Christiane Textor	PT DLR	Germany	unknown/other
Throstur Thorsteinsson	Institute of Earth Sciences	Iceland	research institutes
	ESA	Italy	environmental agencies
Flavio Vetrano	University of Urbino	Italy	research institutes
giorgio spada	UNIURB	Italy	research institutes
Massimo Frezzotti	ENEA	Italy	research institutes
	Univeristy	Italy	research institutes
	International Christian University	Japan	unknown/other
	Utrecht University	Netherlands	research institutes
Ásdís Jónsdóttir	Centre for technology, innovation and culture	Norway	research institutes

Nils Roar Sælthun	University of Oslo	Norway	research institutes
Robert Thomas	SIGMA Space and NASA	Poland	research institutes
	Institute of Geophysics PAS	Poland	research institutes
	Liberal	Portugal	politician
David Muir	Comhairle nan Eilean Siar	Scotland	politician
Prof A Dawson	Univ of Aberdeen	Scotland	research institutes
Blanka Kapustova	Slovak Environmental Agency	Slovakia	environmental agencies
veijo pohjola	Uppsala University	Sweden	research institutes
Wilfried Haeberli	University of Zurich	Switzerland	research institutes
Zemp Michael	Dept. Geography, University of Zurich	Switzerland	research institutes
Lone Le Vay	Chichester District Council	United Kingdom	politician
Ruth Welters	LWEC	United Kingdom	environmental agencies
	NERC	United Kingdom	environmental agencies
	Environment Agency Wales	United Kingdom	environmental agencies
Sue Everett		United Kingdom	unknown/other
Andrew Watkinson	LWEC	United Kingdom	environmental agencies
Tim Reeder	Environment Agency	United Kingdom	environmental agencies
Bill Donovan	Environment Agency	United Kingdom	environmental agencies
John Huthnance	NERC National Oceanography Centre	United Kingdom	research institutes
Michael O'Brien	House of Commons	United Kingdom	politician
Philip Woodworth	NOC Liverpool	United Kingdom	research institutes
Liz Morris	SPRI	United Kingdom	research institutes
Peter Bottomley	Member of Parliament	United Kingdom	politician
	Member of Parliament	United Kingdom	politician
Stephen Metcalfe Mp	House of Commons	United Kingdom	politician
Julian Huppert	Member of Parliament	United Kingdom	politician
chandrika nath	parliamentary office of science and technology	United Kingdom	governmental advisor
Robert Nicholls	University of Southampton	United Kingdom	unknown/other
Chris Sear	DECC	United Kingdom	governmental advisor
Jonathan Wentworth	Parliamentary Office of Science and Technology	United Kingdom	governmental advisor
Scott Mills	Fareham Borough Council	United Kingdom	politician
	Environment Agency	United Kingdom	environmental agencies
Bill Donovan	Environment Agency	United Kingdom	environmental agencies
Carlo Buontempo	UK Met Office	United Kingdom	governmental advisor
Dr Dougal Goodman	The Foundation for Science and Technology	United Kingdom	governmental advisor
	University of Bristol	United Kingdom	research institutes
	British Antarctic Survey	United Kingdom	research institutes
Bryn Hubbard	Aberystwyth University	United Kingdom	research institutes
Andrew Cooper	University of Ulster/Northern Ireland Coastal and Marine Forum	United Kingdom	research institutes
Colin Whiteman	University of Brighton	United Kingdom	research institutes
Peter Wadhams	University of Cambridge	United Kingdom	research institutes
David Woolf	UHI Millennium Institute	United Kingdom	research institutes
Alistair Rennie	Scottish Natural Heritage	United Kingdom	governmental advisor
Baroness Perry	House of Lords	United Kingdom	politician
Stephen Mosley	Member of Parliament	United Kingdom	politician
David Hickman	Lincolnshire County Council	United Kingdom	politician
Jeff Ridley	Met Office	United Kingdom	research institutes
	University of Bristol	United Kingdom	research institutes
Andrew Shepherd	University of Leeds	United Kingdom	research institutes
Ruud Hurkmans	University of Bristol	United Kingdom	research institutes
Slawek Tulaczyk	University of California	USA	research institutes
Ken Mankoff	Univ. California Santa Cruz	USA	research institutes



Jason Box	The Ohio State University	USA	research institutes
Klaus Keller	PSU	USA	research institutes
Mernild	LANL	USA	research institutes
Patricia Rush	Nova Southeastern student	USA	research institutes
Jay Zwally	NASA Goddard SFC	USA	research institutes
Ken Mankoff	Univ. California Santa Cruz	USA	research institutes
Jason Box	The Ohio State University	USA	research institutes
Klaus Keller	PSU	USA	research institutes

Appendix F – Summary of lessons for ice2sea communications

Lesson #1 for ice2sea communications. It might be argued that the most compelling approach to communicating the importance of understanding sea-level rise, and the significance of ice2sea projections, would be through a quantitative description of the changing risk of flooding for specific highly vulnerable areas. However, a focus on such regions as case-studies could potentially have a significant deleterious effect on property owners in that area. *Care must be taken by ice2sea communications to deal with regions fairly, and consider the potential implications in rather generalised ways, keeping in mind the potential effects on individuals and regions. Case studies highlighting vulnerability must only be used with considerable caution.*

Lesson #2 for ice2sea communications. Ice2sea communications should include the important key message that good quality science that increases knowledge and reduces uncertainty will allow delay or complete avoidance of unwarranted expenditure on sea-defence and adaptation. Delaying decisions can often increase the effectiveness of expenditure.

Lesson #3 for ice2sea communications. A full description of sea-level projections must include some effort to define the maximum plausible rate, rates of change, and potentially magnitudes of sea-level rise, even if these cannot be fully simulated by computer models. Ice2sea communications should include low-likelihood, high-impact scenarios, even if these cannot be fully simulated by the current generation of climate and ice models.

Lesson #4 for ice2sea communications. A lack of understanding of maximum rates of sea-level rise may, in some sectors, cause a mis-interpretation of uncertainties in sea-level rise projections, if these are not presented or updated correctly. Ice2sea communications should not assume knowledge in stakeholders which they may not have. For example, uncertainty about total sea-level rise by 2050, decreases for every year that passes (as year-by-year, “possible future sea-level rise”, becomes “past measured sea-level rise”). Thus periodic reassessment of sea-level rise is required, and will mean updating the most likely scenarios. Without an understanding that rates of sea-level rise, and rates of change of sea-level, can be constrained within practical limits, this point could be overlooked, together with the opportunity it provides for planners to develop a sensible adaptation policy, based on a structure decision timetable (c.f. TE2100). *Ice2sea communications should assume no prior knowledge in explaining the implications of our projections.*

Lesson #5 for ice2sea communications. The emphasis on mid-range or upper-range, or maximum plausible estimates of sea-level rise depends on the magnitude and granularity of the risk and those that bear the costs. *Ice2sea communications should recognise that different stakeholders will choose to emphasize different aspects of risk, and that this will reflect the specifics of their own policy arena*

Lesson #6 for ice2sea communications. The managing of sea-defence in the real world is all about the statistics of risk. Sea-defence planners identify a general lack of understanding of the non-linearity of the impact of sea-level rise on risk, with which ice2sea could assist. However, the non-linearity works both ways and should not simply be presented in terms of increasing risk, the significant caveat that improvements in sea-defence infrastructure have substantial beneficial impacts on risk should not be over-looked.

Lesson #7 for ice2sea communications. The relationship between the individual and the state is a key factor in our perception of risk and responsibility, which strongly modifies the way that messages are taken up by different stakeholders. In response to the example of the USA, a landowner might want to emphasise the most-likely (mid-range), or even the low estimate, whereas the planner might emphasise the upper estimate. *Communication of ice2sea output needs to reflect the full range of assessments, but also to emphasise that we expect to make progress in refining estimates in the future.*

Lesson #8 for ice2sea communications. The magnitude of sea-level projections is already influencing decisions. The example of the USA suggests that unjustifiably high projections of sea-level rise will, under some conditions, have a paralysing effect on sea-defence planners. This means that sound sea-defence plans that should be considered may not, in fact, be pursued because it is thought that they will eventually be unsustainable. *The ice2sea message should attempt to define justifiable likelihoods to the highest projections, so that undue weight is not placed on the extremes of the distribution.*

Lesson #9 for ice2sea communications. Our efforts to engage with stakeholders in the private and charitable sectors were less successful than hoped. Either awareness of issues of sea-level rise in these sectors is poorer than in the public sector or academia, or the routes to engagement used by ice2sea need to be improved. However, no matter how we aspire to engage with the widest possible stakeholder community, it should be noted that a sizeable audience for ice2sea research exists in the academic environment, and failing to serve these interests would be to ignore a ready audience.

Lesson #10 for ice2sea communications. One of the important differences of the ice2sea project to other previous work is the intended focus on a timescale of 200 years. While most stakeholders understandably focus on shorter timescales, there is a significant interest in such long-term projections, and the emphasis of ice2sea communications needs to reflect this.

Lesson #11 for ice2sea communications. These responses show that all spatial scales are significant to our stakeholders, and to the extent that it is possible, ice2sea communications need to reflect the local to global picture.

Lesson #12 for ice2sea communications. There is a wide interest in the impacts of sea-level rise across the areas of interest declared by stakeholders. A broad approach to communication is required in this regard, and a specific emphasis on particular impacts to particular stakeholders is not justified.

Lesson #13 for ice2sea communications. Half of ice2sea stakeholders claim to have a working knowledge of statistics which suggests that communications should not implicitly underestimate the skill of stakeholders in interpreting statistical representations. However there are sufficient significant numbers of stakeholders involved in strategy and implementation of sea-level rise projections who want a simple best estimate, and along with an explanation of probabilities, a headline figure should also be included.

Lesson #14 for ice2sea communications. All groups of stakeholders wish to see results presented graphically. Even policy makers are not interested just in an executive summary.

Lesson #15 for ice2sea communications. Ice2sea stakeholders on the whole (85%) say they understand measurement uncertainty and the way it is communicated. They declare an interest in the sources of uncertainty in projections, and so this should be incorporated into ice2sea communications.

Lesson #16 for ice2sea communications. The clear importance of the website as a communication tool has been highlighted. For this reason, the ice2sea website, www.ice2sea.eu, should be professionally redeveloped, to give a better design feel, and easier to access content. Ice2sea science journal papers, and other published articles, should be easily accessible through the website.

Lesson #17 for ice2sea communications. We should consider establishing some regular contact with stakeholders to keep them informed of developments, and alert them to upcoming information.