

How does peer-reviewed scientific literature affect policy decisions?

Instructional Objectives

At the end of the lesson, students will be able to:

1. Identify popular vs. peer-reviewed literature.
2. List steps in the peer-review process.
3. Describe what type of source is used to construct reports used by governments to create policy.
4. Discuss difficulties in monitoring glacier health.
5. Identify the largest source of uncertainty in future glacier health and what steps are being taken to remedy this uncertainty.
6. Describe why climate change is a political contentious issue.
7. Describe the ramifications of stating unverified opinions as scientific facts.
8. Discuss the utility of assessment reports such as the United Nation's Intergovernmental Panel on Climate Change Assessment Report.

Content Explanation

Many students, and people in general, do not realize the separation between peer-reviewed scientific literature and scientific facts reported in the popular press. Peer-reviewed articles are published through a formalized process where a submission is revised after being reviewed by external, impartial experts. All parties (the authors, reviewers, and an editor who oversees the review process) approve of the final version before publication in order to ensure accuracy. Although the content may not be completely correct, uncertainties, extrapolations, and interpretation are clearly stated so that a close reading of the article precludes misconceptions. An article in the popular press, despite an author's best attempt at accuracy, is not subject to a formal vetting process by topical experts and is thus more likely to include unintentional errors. This lesson examines one incident where an inaccurate statement reported in the popular press was inadvertently included in a peer-reviewed report intended to provide information to policy-makers on a politically contentious issue (climate change and water supply).

Lesson Summary

Students will read articles related to a misstatement of future glacier health in the Himalayas that was reported in the 2007 United Nation's Intergovernmental Panel on Climate Change Assessment Report 4. The class will discuss the articles and ramifications of inaccuracies in scientific literature as well as the importance of validating sources as peer-reviewed. As this topic is complex, the students will need guidance in the form of an introduction to peer-reviewed literature, which is outlined here. Furthermore, the objective of this lesson is not to vilify the IPCC or any other well-intentioned group, but rather to elucidate the use of proper references and procedure when summarizing a contentious scientific issue with broad geopolitical implications.

Peer-reviewed literature refers to a document that has been reviewed by other subject experts before being published. First, a group of scientists investigates a scientific question using models, lab experiments or observations. After processing data, refining models, or explaining observations, the group proceeds to write a manuscript. This manuscript is then submitted to a journal. The editor of the journal reads the manuscript, decides if it is suitable for publication in that journal, and selects reviewers external to the work who are experts in the field. The manuscript is then sent to reviewers who make comments, may attempt to replicate the work, identify caveats in the experiment or explanation, and otherwise attempt to constructively criticize the manuscript in order to advance the science. Once the review is complete, and assuming the editor decides not to reject the manuscript based on the review, the comments are submitted to the author who must carefully respond to each before resubmission. This process may iterate several times before all parties are satisfied with the work and it becomes a publication. Although this process is imperfect, it tends to minimize incorrect conclusions, prevent duplicate work, and is generally an efficient manner to advance the science. Included in this process is a clear assessment of what is fact, uncertainties in observations, and what may be interpretation or extrapolation designed to foment creativity in addressing a problem.

Due to the highly technical nature of many scientific topics and the voluminous literature that addresses current research in an active field, synthesis reports are necessary so that policy-makers and the public can become informed and make decisions as needed. Therefore, panels of experts, such as the United Nation's Intergovernmental Panel on Climate Change (UN IPCC) have an exceedingly important purpose: to sift through peer-reviewed literature, much of which may be in conflict despite the peer-review process, and distill the state of the science into a succinct report. Generally, these reports are well intentioned and the scientists make sincere efforts to give an impartial, perhaps laconic, assessment of the science in a field. Here we report on a singular error in the UN IPCC and the ramifications of such an error as an example of the importance of adhering to established peer-review procedure when giving advice which may be used to formulate policy. In general, the IPCC has provided highly accurate advice on the current state of climate change and made clear that warming is unequivocally due to anthropogenic influences. Furthermore, the statements about projections of future warming, its effects, and mitigation efforts have been valuable to policy-makers worldwide. Perhaps the salient point of this lesson is that one error was made due to a singular oversight in procedure and does not invalidate the body of evidence in this support.

The error examined here is the citation of a popular interview in a document that nominally and truly, except in this case, only cited peer-reviewed literature. We hope that students learn the difference between peer-reviewed and popular literature, learn to read assessment reports and assimilate information quickly, and analyze political implications of scientific problems.

Administrative Considerations:

This lesson involves a lot of reading. ESL students may have trouble with comprehension. Students with lower reading comprehension skills may need some guidance. Some of the articles are from peer-reviewed journals and therefore may need to be accessed via libraries with paid. Some of the readings are rather voluminous so content is summarized and especially important sections are identified.

Materials: Articles and questions sheets. Articles used are listed below.

Fourth Assessment Report of the Intergovernmental Panel on Climate Change 2007, Synthesis Report (available http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf). Sections important to read: Introduction, Chapter 1, and Chapter 3.3.

Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Chapter 10.6.2. (available <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter10.pdf>).

World Wildlife Fund Report on Himalayan Glaciers, 2005 (available assets.panda.org/downloads/himalayaglaciarsreport2005.pdf).

UN IPCC Statement on Himalaan Glaciers (available <http://www.ipcc.ch/pdf/presentations/himalaya-statement-20january2010.pdf>)

Immerzeel, W. W., L. P. H. van Beek, and M. F. P. Bierkens (2010). Climate Change Will Affect the Asian Water Towers. *Science*, 328,1382-1385.

Questions on Climate Change 2007 Synthesis Report

Questions on Introduction

1. Although not explicitly stated in the introduction, who would you intuit is the audience of a report like this one?
2. What is the main difference between the Third Assessment Report and the Fourth Assessment Report? What type of policy decisions is this report now designed to address?
3. Why is the treatment of uncertainty highlighted so early in the report?
4. What are the differences in uncertainty assessment of social and natural sciences?
5. Is the assignment of specific terminology to a numerical uncertainty useful (i.e. "very unlikely <10%")? Or does it confuse qualitative uncertainties and quantitative uncertainties?

Questions on Synthesis Report Chapter 1

1. What language does the report use to describe evidence of warming? Name direct and ancillary lines of evidence that warming is occurring.
2. What uncertainties are assigned to observations of extreme weather events?
3. What are the observed effects of warming? What uncertainties are assigned to these changes? Over what spatial scale do these observations apply?
4. What uncertainty is assigned to evidence of regional changes? What does this indicate about the state of the science?

Questions on Synthesis Report Chapter 3.2.3-3.3

1. What is the main point of section 3.2.3? Which set of key processes related to ice sheets are not included and what is the quantitative assessment of their uncertainty and their future impact on ice sheet health?
2. How are the impacts categorized in section 3.3.1? Does this suggest a natural science organization scheme or another? Why might this be important?

3. What is the purpose of the highlighted (in yellow on pg. 49) topical section on water usage? In what areas are glaciers identified as especially crucial to future water supplies?

Summary:

This report is a synthesis of an extensive report on the current state of physical and social science regarding climate change as the science stood in 2007, and, although sponsored by the United Nations, was generated through the prodigious effort of many scientists who addressed every single comment to the report, from expert or layman, and agreed on the language of the report in their individual working groups. Although not directly stated, the report is aimed at aides to policy-makers who will distill the vital information into an even more succinct form. Uncertainties are immediately identified and specific terminology is assigned to quantitative uncertainties based on physical results. These words appear similar to words adopted for uncertainties in social science, but the two types of uncertainties should not be equated conceptually as they refer to fundamentally distinct ideas. Uncertainties in the natural sciences are assigned based on statistical analysis, agreement between a broad set of direct observations with appropriate instrumental uncertainty, or agreement of double-blind experiments and model results. Social science uncertainty is qualitative and is assessed based on degree of agreement in the literature according to intuitive terms that are generally taken as self-explanatory.

The next two sets of questions address examples of the use of uncertainty in the report regarding specific scientific issues. The questions are designed to lead students to assess when natural or social uncertainties apply and a quantitative can be assessed to a social phenomenon. They also aim to highlight the current state of climate science, which is that global observations of warming are very robust and global climate models are also quite robust. Regional effects of global warming are now beginning to be observed with moderate confidence and models are beginning to provide reasonable simulations of observations. The area of largest uncertainty in future sea level, climate models, and global glacier health that is not addressed in current models is dynamic processes of ice sheets. There is no consensus on either the rapidity at which ice sheets can change or on the magnitude of such changes. Section 3.3.1 begins to relate scientific issues to social ones. The highlighted section concerns future water availability and is of special note due to its possible geopolitical preponderance. Of paramount note in this section is the proposed sensitivity of several areas of high population to future glacier health. As all of these areas are undergoing both high population growth and rapid industrialization, future water use is especially politically contentious, and extraordinary care is needed when making observations that may influence policy and thus people's lives directly.

Questions on WGII report Chapter 10.6.2 of the IPCC 2007 AR4 (available www.ipcc.ch)

1. How many people live in the Gangetic Basin? According to this report, how are Himalayan glaciers related to water availability?
2. What significant items in scientific writing are missing from the first paragraph?
3. The second paragraph cites that current retreat rates of Himalayan glacier retreat are the fastest in the world and makes the ominous prediction that Himalayan glaciers may melt entirely by 2035. What reference do they cite? Is this type of report subject to the same degree of critical rigor as a study in a peer-reviewed journal?
4. What citations are given in the paragraph discussing the effects of glacier melt on river discharge? Which results are directly cited? Which are not? What does that imply about the reputability of such statements?

Summary:

Working Group II of the Intergovernmental Panel on Climate Change is charged with assessing vulnerability to, impacts of and adaptations to climate change and was composed of scientists with expertise relevant to that objective. Working Group I is responsible for the scientific basis of climate change and making prediction (with proper uncertainty) about the future state of Earth's climate including the future health of the world's glacier. The section above is part of the report written by the working groups and makes significant predictions regarding future glacier health; therefore they may have exceeded their auspices. Furthermore, in this specific case - the prediction that Himalayan glaciers may disappear by 2035 - the report does not cite Working Group I but rather WWF (2005) as source. We will investigate this source in the next reading.

WWF Fund Himalaya Glacier Support Regional Summary and India Introduction

1. Who is the intended audience of this report? Why would an organization like the World Wildlife Fund write a report on glaciers?
2. What type of information does the historical overview present? Would the same type of information be presented if the primary audience were intended to be scientists?
3. Page 2, paragraph 1 begins with “Research shows.” Is this type of information appropriate or helpful?
4. The subsection, “Overview of the Problem,” begins with a citation from a researcher in *New Scientist* magazine which states that most of the glaciers in the Himalayan region “will vanish within 40 years as a result of global warming.” Would you consider this statement peer-reviewed? Why or why not?
5. What are the major risks associated with glacier retreat?
6. What are glacial lake outburst floods? When do they occur? With what type of manmade cataclysm is this phenomenon analogous?
7. Analyze the language. What adjectives would you use to describe it? Is it appropriate in scientific discussions?

Summary:

This report is clearly intended for internal discussion in the World Wildlife Fund as well as for distribution to interested external parties including those who fund the organization. Such reports fall under the auspices of the World Wildlife Fund as glacier mass wastage contributions to changing ecosystems and such changes have broad aspects across all trophic levels of an ecosystem including fauna which are the World Wildlife Fund’s primary concern. The information presented at the beginning of the report is clearly meant for non-specialists, as active researchers would be familiar with the basis of ice ages and scientific vernacular. Statements throughout the main text show that the report, although intending to be informative, is not intended to be a peer-reviewed document in primary scientific literature. Furthermore the language is too dramatic, even at times apocalyptic, and does not quantify the facts it justifies with either numerical or conceptual uncertainties. They also fail to clearly state whether they are citing observations or extrapolations; a distinction which is very clear in peer-reviewed literature. The statement at the bottom of page 23 (directly quoted later in the India Introduction) is clearly not peer-reviewed and was one scientist extemporaneously responding to a

question. Such non-refereed statements should never be given the same validity as a citation from a peer-reviewed article. This statement was an exaggeration and although present day glacier mass loss in the Himalaya is likely only a harbinger of future losses, there is no reason to suspect that the glaciers will vanish in 40 years (Jacob et al., 2012).

Despite the fact that this is not a peer-reviewed document, it is, in my opinion, still a useful one. Reports such as these inform people without access to peer-reviewed literature and are often primary sources for background knowledge. Listing of risks with glacier retreat, including threats to freshwater supply, glacial lake outburst floods, and economic consequences of glacier retreat, illustrate the extent to which a seemingly esoteric problem, glacier retreat, can have consequences that quickly proliferate to affect people's lives in many ways. Thus, although not peer-reviewed literature, this document still serves an important purpose, it just should not be cited in the same manner as an article in a peer-reviewed journal.

Letter Regarding IPCC statement on melting of Antarctic Glaciers

1. What is the purpose of this letter? Does it achieve this purpose?
2. Does one error imply a degree of pathology in the IPCC report or is this error a singular aberrance? How significant is it that only one official retraction has ever been issued in its history as an institution (keeping in mind the four assessments reports each several thousand pages in length with a massive review of literature)?
3. This letter shows that scientists writing peer-reviewed papers or reports are held accountable for their statements. Does the same degree of accountability hold in other fields?

Summary:

This letter is the official response to from the United Nations Intergovernmental Panel on Climate Change. It begins by citing the statement in the synthesis report which is most likely to be read by those directly involved in policy and reaffirming the robustness of the statement in this report. They then cite the error directly in both places where it occurs. Finally, they state that the paragraph with the error did not follow the official evidentiary procedures of IPCC in properly assessing source validity.

The goal of this letter is twofold: to publically acknowledge the error and to reassure the public that there is nothing pathologic concerning the body of evidence in this report. Their claim is reinforced by the fact that this is the first retraction published in four assessment reports. The fact that the error occurred shows that the science is still progressing and that occasional errors do occur. The peer-review process, including an official retraction policy promulgated by not only the IPCC but nearly every peer-reviewed journal, provides a framework through which errors can be remedied in a responsible manner. Thus in addition to initially decreasing the probability of a publishing an erroneous, the peer-reviewed procedure allows responsible retraction of an error.

As scientists frequently receive public funding, they should be subject to a certain degree of public accountability, which is partially ensured by the peer-reviewed process. In addition to peer-review of publications, every proposal to receive funding is also subject to peer-review by a panel of subject experts. Both the publication process and the funding process are competitive and are intrinsically designed to minimize the ability of an individual, or small group, to “highjack” the science as other individuals are likely to identify ulterior motives and deny publication or funding.

Immerzeel, W. W., L. P. H. van Beek, and M. F. P. Bierkens (2010). Climate Change Will Affect the Asian Water Towers. *Science*, 328, 1382-1385.

1. What type of journal is Science? Are publications within it always fully correct?
2. Is the analogy between a glacier and a water tower in the title of the article appropriate and illustrative? What are some extended allusions created by this colorful language?
3. Which rivers are the focus of this study? What parameters are important in this study?
4. What sort of atmospheric projections are used to model the future river discharge flux? Where do the atmospheric projections originate? What does this indicate about the scientific community's view of the Intergovernmental Panel on Climate Change?
5. Which rivers are sensitive to glacier melt? How can you glean this information from Figure 3?
6. What sort of consequences will reduction of river water flux discharge caused by glacier mass loss have? How many people will be affected and where will the effects be the strongest?
7. What is the possible effect of climate change on the Yellow River? Why?
8. If you were a policy-maker, what information would you cite from this article? Would you be influenced by your political stance? Should you be?

Summary:

This article is a scientific study of future river water flux discharge for 5 major Southeast Asian Rivers that are partially supplied by Himalayan glaciers; discharge in these basins may decrease if glaciers melt. They begin by citing a number of parameters (Table 1) that highlight the importance of these river basins to future populations. The authors use the IPCC medium range atmospheric climate projection with hydrological modeling that incorporates uncertainty in glacier response to predict future river discharge 50 years from now. They then compare this projection to current measurements. The results show that the Indus and Brahmaputra basins are at high risk for future river flux discharge decrease as a result of glacier melt and that the decrease in discharge will likely happen when the most water is needed for agricultural purposes. The authors state that the reduction in water availability will likely result in these 2 basins being less capable of supplying food to current populations. The decrease in people that can be fed from these 2 basins totals ~60 million (Immerzeel et al., 2012). This number is significant and does not overstate (despite

uncertainties attached) the ways in which people may be directly affected by a reduction in available water due to glacier melt (and thus eventual reduction in glacier meltwater production). The supplementary materials for this article clearly state which projections are used and the calculation of uncertainty. Although these 2 basins will be affected by glacier melt, the other three, from this study at least, are relatively unlikely to be affected by future melt. The Yellow River will likely have increased discharge due to increased precipitation, which could enhance water availability. Other possible effects of the enhanced precipitation, for example flooding, are not discussed. People reading this could interpret it in a variety of ways. For example, some would view the results presented here as a validation of the threat of glacier melt to water availability in Asia; others would say this article should lessen the fears of future water shortages in Asia. This one article could be interpreted either way; the duality of interpretation is the exact reason scientists should be consulted when discussing natural phenomenon as they are familiar with all the literature and can present a brief summary. Consulting multiple scientists ensures a variety of viewpoints which ensures availability of balanced information that is useful to policy-makers.