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Climate Change, Education, and Stakeholders

Two fundamental elements involved in educating stakeholders about climate change include knowledge and data transfer, and the learning process. Climate change is a complex issue that includes traditional physical science components, along with discussions of environmental and societal impacts, adaptation, and mitigation. Science-policy linkages around these concerns require on-going educational partnership and collaboration between scientists and stakeholders. This statement focuses primarily on the climate risk, impact and adaptation aspects of such education experiences, as synthesized from the author's activities over the past 12 years.

I. Knowledge and Data

The amount of climate change information has grown dramatically in recent years, and will continue to develop and emerge over the next decade and beyond. Given this, it is critical that the climate change education of stakeholders include: 1) basic information dissemination via examples and illustration; 2) fundamental honesty and openness; and 3) presentation utilizing terms and concepts that are meaningful to stakeholders.

Basic Information Dissemination

New and emerging knowledge and data should be presented to the stakeholders as data becomes available. Data on past and present climate conditions including information on annual and seasonal temperature shifts, and annual and seasonal precipitation changes provide a starting point. It is important to state that the climate in a locale is dynamic and most liking already undergoing a process of directional change. For example, information on seasonal variability (e.g., winter, spring, summer, fall) is important because it provides an example of how climate change will not simply shift the climate overall in a uniform manner. Instead, varying changes will occur throughout the year. Data on extreme events, most typically large rainfall events and intense droughts, give additional perspective on how the climate could be changing. Discussion on recent extreme events, particularly flooding events or other damaging weather events (e.g., extreme wind events, heatwaves) illustrates current and possible future local exposure and vulnerability.

Scenario information of future climate change is a critical piece of the information to provide to stakeholders. This presentation serves two primary roles. The first is to illustrate potential future shifts in regional or local climate, and the second is to provide a primary lesson on the process of climate change modeling and associated caveats. Most current modeling efforts will be conducted to provide information on how climate will change throughout this century. It is crucial that the stakeholders understand the basics of how the climate model data are constructed, and the following points:

- Climate models are forecasts and projections and should be presented as summaries of multiple model outputs; they do not produce information on weather or climate of specific days, seasons, or years in the future;
- Climate models produce information at specific spatial scales, typically grid boxes of approximately 100 km^2, and often are not 'downscaled' to finer spatial scales or specific points on the earth's surface.

At a minimum, scenarios of future climate should include information on shifts in trends in annual and seasonal precipitation and temperature, changes in extreme events (e.g., large rainfall events, flooding, days over 90 and 100 degrees Fahrenheit), and catastrophic events as appropriate such as hurricanes, ice storms, etc.). If the locale is coastal, estimates of accelerated sea level rise and coastal flooding should be included as well.

In the end, it also will be important to listen and work closely with the stakeholders to determine which types of climate change data would be most helpful and meaningful to them.

Fundamental Honesty and Openness

A crucial component of data and information transfer and education of stakeholders about climate change is the specification of what is known and not known, and that is the relative strength of the climate change science.

It is obviously crucial that stakeholders understand the scientific consensus regarding climate change as a process generally, and for the locale in question specifically. Central to the climate change education process is the presentation of information about the uncertainty and risk (i.e., potential of occurrence). A current convention to document level of consensus is the IPCC-derived likelihood statements (see IPCC website).

Describing to the stakeholders how and where the science is emerging also is valuable. For example, in the past year and a half sea level rise projections have more than doubled in some cases with the increased possibility of rapid ice melt occurring in the polar regions. Illustrating the shifts in these projections and how they are emerging provides stakeholders with a sense of how the science is changing. Equally important is to show them the new and developing science, and describe how the edge of the science could change in the near future. What will likely be better understood in the near future, and what will be still unclear are important questions.

In summary, telling an audience what the current climate science cannot say is equally important to what it can say, and in turn giving evidence of the dynamism of our knowledge base is critical.

Meaningfulness to Stakeholders

Presenting information in way that connects with terms and concepts that are meaningful to stakeholders is another important step in the educational process. Stakeholders by definition work in agencies and organizations whose goals and objectives are at least to

some extent focused on climate related risks and potential loss reduction. The concept of climate risk within these organizations is often defined by past experiences either within the institutional memory of the staff or the office itself. To best connect with the character and structure of this memory, future climate risks can be presented within context of historical precedents and 'what if' statements and analogies.

Historical precedents include hypothetical statements about the potential impact of past extreme events occurring in the future. For example, to best understand the role that sea level rise might play in extending the storm surge inundation zone, one can present a past storm surge event of record with future climate change-driven sea level rise. 'What if' statements providing illustration of the impact of a well known extreme event from one location occurring in another location is a powerful educational device – e.g., 'what if' a Hurricane Katrina strength storm occurred impacted New York City in 2050.

Climate risk also can be presented within the context of analogies and comparisons. Comparative risk and uncertainty statements, for example, can be made when connecting other hazards and disasters (e.g., earthquake risks) to climate change impacts. With respect to adaptation and adaptive capacity, illustrating the response capacity of institutions, households, and communities to past risks (e.g., water pollution, air pollution, hazardous waste and fire) is useful for understanding and identifying opportunities and challenges ahead for the same entities in the face of climate change risk.

Given these past experiences and their potential relevance to future climate change response and management, it is particularly important to present climate risk within the context of terms and concepts relevant to stakeholders. For example, since most agencies and organizations responding to climate change are managerial and technocratic in structure, often with a significant engineering component, it is useful to present impact and adaptation statements as probabilities and likelihoods with connections to codes and standards, regulations, and scenarios.

As a final point regarding climate knowledge, whenever and wherever possible, it is best to define and present clear and easily accessible statements for stakeholders. Examples that have proved to be valuable include "the environmental baseline is changing, so existing codes and standards should be evaluated for potential adjustment" and "past climate is no longer as good a predictor of future climate." These types of statements serve two roles. First, they provide meta-narratives for knowledge transfer, and second they provide engagement opportunities where stakeholders can adapt these statements to their own understanding and presentation of climate change to their peers, colleagues, and other audiences.

II. Learning Process

Climate change information and data can best understood by stakeholders within a set of learning frames and opportunities. These can be defined as specific actions that the climate change specialist can take when engaging with stakeholders.

Meeting with Stakeholders

Meeting with stakeholders on their ground and in their space is crucial. Attending specific stakeholder meetings illustrates one's commitment to the process. Identification of particular meetings to attend can be determined in consultation with stakeholder representatives. Once onsite, it is important to be flexible and engaging – both being responsive to questions and asking questions about the stakeholder's observations, concerns, and plans vis-à-vis climate change. It is important to use questions (even uniformed ones) as educational opportunities to relieve ignorance and move the discourse forward. Overall, it is crucial to recognize that meaningful engagement will be more than a one-time presentation but would require an ongoing dialogue with formal and/or informal elements.

Connecting with the Stakeholder Process

A second important component of the learning process is connecting one's knowledge transfer with the process and mission of the stakeholder agency and organization, and to explicitly think about what connection points with climate change will make sense to the stakeholders. Climate risk will be perceived differently within agencies, offices, bureaus, or departments in any specific governmental entity (e.g., municipal, county, state, federal). Climate risk, for example, can be either defined as a problem within a suite of other critical public policy issues (e.g., housing, transit congestion; as an incremental problem which demands response within existing management cycles and planning activities such as water supply and sewerage system regular capital upgrades); or, as a condition which could result in a potentially catastrophic disaster (e.g. storm surge emergency response and management planning). Consideration of the linkages between climate risk and agency mission, and making appropriate adjustments before and during stakeholder engagement could have a very positive impact on the effectiveness of the educational experience for all parties.

Furthermore, an overall picture has started to emerge of the roles, responsibilities, and conditions that stakeholders use to connect with climate change risk and adaptation. These include the following:

- Specify activity/infrastructure at risk to climate
- Define risks in current and future climate
- Characterize adaptation options
- Operations/management, infrastructure investment, policy
- Link to capital cycles
- Time-scales - short, medium, long-term
- Conduct feasibility screening
- Engineering, institutional, and regulatory feasibility
- Evaluate adaptation options

The recognition and incorporation of these into one's climate change presentations and conception of stakeholder interests will enhance the transfer experience.

Empowering Stakeholders

A last yet paramount component of the transfer experience is to empower the stakeholders to make the climate change information and data their own. Empowerment can be fostered through at least three actions. First, it is important to connect with leading individuals and/or early adaptors within the stakeholder entity and partner with them as potential champions of the issue within their agency or organization. These individuals will legitimate the process and method of engagement, and the information and data itself to their peers and colleagues.

A second action in the empowerment process is to acknowledge when it is appropriate to step back from the stakeholders as they begin to consider, interpret, and apply the climate information and data within their own decision frames. As knowledge is received within the stakeholder agencies and organizations, the material should become part of their operations and planning. While it will be important to be available and engaged if misrepresentation occurs, it is advisable to let the stakeholder test applications of the knowledge without additional intervention.

This directly leads to a third action which climate researchers can easily forget. It is essential that the scientists do not overstep boundaries and their roles. Scientists are scientists; not policy-makers or stakeholders. Stakeholders conceive of scientists in this way, and when the scientists attempt to exceed this role it both hampers their legitimacy (because they could be seen as having an agenda), as well as the ability of the stakeholders to fully engage with the knowledge and to consider it without undue to prejudice and burden.

III. Conclusion

In summary, the educational connection between climate scientists and stakeholders is multi-faceted and dynamic. The experience is generally representative of the larger question of climate change and societal response to it – it is complex, transformative, and just beginning.