Weathering Uncertainty: Traditional knowledge for climate change assessment and adaptation

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United Nations
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Convention on Biological Diversity

United Nations Educational, Scientific and Cultural Organization

Natural Sciences Sector
Local and Indigenous Knowledge Systems Programme

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Contents

Executive Summary

When considering climate change, indigenous peoples and marginalized populations warrant particular attention. Impacts on their territories and communities are anticipated to be both early and severe due to their location in vulnerable environments, including small islands, high-altitude zones, desert margins and the circumpolar Arctic. Indeed, climate change poses a direct threat to many indigenous societies due to their continuing reliance upon resource-based livelihoods. Heightened exposure to negative impacts, however, is not the only reason for specific attention and concern. As many indigenous societies are socially and culturally distinct from mainstream society, decisions, policies and actions undertaken by the majority, even if well-intended, may prove inadequate, ill-adapted, and even inappropriate. There is therefore a need to understand the specific vulnerabilities, concerns, adaptation capacities and longer-term aspirations of indigenous peoples and marginalized communities throughout the world. Indigenous and traditional knowledge contribute to this broader understanding.

Indigenous and rural peoples, however, are not only potential victims of global climate change. Attentiveness to environmental variability, shifts and trends is an integral part of their ways of life. Community-based and local knowledge may offer valuable insights into environmental change due to climate change, and complement broader-scale scientific research with local precision and nuance. Indigenous societies have elaborated coping strategies to deal with unstable environments, and in some cases, are already actively adapting to early climate change impacts. While the transformations due to climate change are expected to be unprecedented, indigenous knowledge and coping strategies provide a crucial foundation for community-based adaptation measures.

Indigenous knowledge was acknowledged in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) as 'an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change' (IPCC, 2007). This recognition was reaffirmed at IPCC's 32nd Session (IPCC, 2010a) and consideration of traditional and indigenous knowledge was included as a guiding principle for the Cancun Adaptation Framework (CAF) that was adopted by Parties at the 2010 United Nations Framework Convention on Climate Change (UNFCCC) Conference in Cancun (UNFCCC, 2010). The outline of the IPCC's Working Group II contribution to the Fifth Assessment Report (AR5) includes local and traditional knowledge as a distinct topic within Chapter 12 on human security.

This report provides an overview of the published scientific literature (primarily peer-reviewed, but also grey) relating to the contribution of traditional/indigenous knowledge to our understanding of global climate change: observations, impacts and opportunities for adaptation. It focuses in particular on post-AR4 literature and also includes inputs from the international expert meeting 'Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge', held from 19–21 July 2011 in Mexico City, Mexico.

While the report does not purport to be comprehensive, it nevertheless attempts to draw attention to essential baseline information, key sources of data and continuing areas of debate. A selection of key points is presented below.

Indigenous Knowledge as a Foundation for Decision-making

1. Indigenous peoples live in all regions of the world and own, occupy or use resources on some 22% of the global land area, which in turn harbours 80% of the world's biological diversity. While there is no single definition for indigenous peoples, a core set of criteria guide the identification of this highly diverse group.

2. Indigenous or traditional knowledge refers to the knowledge and know-how accumulated across generations, and renewed by each new generation, which guide human societies in their innumerable interactions with their surrounding environment.

3. Although nascent in climate science, indigenous knowledge has been widely recognized in fields such as agroforestry, traditional medicine, biodiversity conservation, customary resource management, applied anthropology, impact assessment, and natural disaster preparedness and response.

4. Indigenous observations and interpretations of meteorological phenomena have guided seasonal and inter-annual activities of local communities for millennia. This knowledge contributes to climate science by offering observations and interpretations at a much finer spatial scale with considerable temporal depth and by highlighting elements that may not be considered by climate scientists.

5. Indigenous knowledge focuses on elements of significance for local livelihoods, security and well-being, and as a result is essential for climate change adaptation.

Indigenous Knowledge, Vulnerability and Resilience

6. Indigenous peoples and marginalized populations are particularly exposed and sensitive to climate change impacts due to their resource-based livelihoods and the location of their homelands in marginal environments.

7. Small population size, isolation, and the absence of recognized rights over their territories and resources may also contribute to their vulnerability to economic, social and environmental impacts brought about by a changing climate.

8. Despite their high exposure-sensitivity, indigenous peoples and local communities are actively responding to changing climatic conditions and have demonstrated resourcefulness and resilience in the face of climate change.

9. Indigenous knowledge and knowledge-based practice are the foundations of indigenous resilience.

10. Strategies such as maintaining genetic and species diversity in fields and herds provide a low-risk buffer in uncertain weather environments.

11. Diversified use of the landscape, mobility and access to multiple resources increase the capacity to respond to environmental variability and change, including climate change.

12. Traditional systems of governance and social networks contribute to the ability to collectively respond to environmental change and thus heighten resilience.

13. Gender equality in climate change policies and responses contributes to enhanced resilience and adaptive capacity.

14. Climate change, however, is only one of many drivers of change. Its effects cannot be isolated from the multiple social, political, economic and environmental changes confronting present-day indigenous and marginalized communities. These impacts interact together and induce exacerbating and cascading effects.

Traditional Livelihoods

15. Traditional livelihoods are the mainstay of large segments of the world's population. Pastoralism is practised on an estimated 25% of the global land area and provides 10% of the world's meat production. The majority of the world's fishers are artisanal.

16. Subsistence livelihoods are typically small-scale, diversified and rely upon a suite of specialized skills. The mastery of multiple livelihood skills is a source of resilience in times of uncertainty and change.

17. Diversification provides a buffer against environmental variability and change. Nomadic herders vary the species and genetic composition of their herds, while small-scale farmers manage risk through their choice of diverse domestic crops and plant varieties, backed up by reserves of wild resources.

18. Land use strategies are another traditional source of resilience. Pastoral peoples move their herds in response to changing environmental conditions and reserve certain pasture areas for years when conditions are extreme. Swidden farmers benefit from multiple resources from fields and forest in multiple stages of fallow and regeneration.

19. Policies that provide incentives to abandon traditional livelihoods may undermine the ability of these local knowledge-based systems to respond to environmental change.

Adaptation Policy and Planning

20. Indigenous peoples have long and multi-generational histories of interaction with their environments that include coping with environmental uncertainty, variability and change. They have demonstrated their resourcefulness and response capacity in the face of global climate change.

21. Resilience in the face of change is rooted in indigenous knowledge and know-how, diversified resources and livelihoods, social institutions and networks, and cultural values and attitudes.

22. An understanding of how policies may affect indigenous resilience is key to creating a policy environment that supports community efforts to adapt through opening up options and encouraging innovation in the face of uncertainty.

23. Some governmental policies have negative effects on adaptive capacity. By removing options and reducing choices, they constrain, restrict and undermine community efforts to adapt.

24. Policies supporting resilience and adaptability include those that maintain the integrity of and access to traditional territories, reinforce local practices sustaining crop or herd diversity, and enhance transmission of indigenous knowledge, values, attitudes and worldviews.

25. Decision-making processes for climate action are most effective if they are accountable and responsive to the populations that are affected, and provide support for full and effective participation and representation in climate governance.

26. A crucial challenge is to ensure that indigenous peoples are involved as key partners in the development of climate change research and adaptation plans.

27. Collaboration between indigenous knowledge holders and mainstream scientific research is generating new co-produced knowledge relevant for effective adaptation action on the ground.

28. An increasing number of indigenous peoples (particularly in developed countries) are moving towards the creation of formal adaptation plans. However, adaptation planning and research is not evenly distributed across all regions.

The Americas: Regional Report

29. Climate change is already severely impacting indigenous livelihoods in the Americas.

30. Indigenous knowledge relating to climate change, whether it concerns agricultural techniques, biodiversity, indicators of change, or weather prediction and response, provides the basis for many successful and cost-effective adaptation measures.

31. Indigenous knowledge transmission is threatened by social, cultural and environmental drivers, including climate change, resulting in erosion of the knowledge base and its potential to support climate change response.

Arctic/Northern Polar Regions: Regional Report

32. Indigenous knowledge and the first-hand experiences of Arctic communities are an essential foundation for the formulation of locally relevant adaptation strategies.

33. In the harsh Arctic environment, indigenous knowledge provides the basis for risk management, as well as safety and survival skills. Erosion of these skills among younger generations is a concern for elders, given the increase in weather unpredictability due to climate change.

34. Indigenous Arctic communities are providing systematic observations of climate change impacts, which complement scientific data and frame local adaptation efforts.

Small Islands: Regional Report

35. Small island societies have lived for generations with considerable and often sudden environmental change. The traditional knowledge and related practice with which small island societies have adapted to such change are of global relevance.

36. Areas in which small island societies have developed adaptation-relevant traditional knowledge include natural disaster preparedness, risk reduction, food production systems and weather forecasting.

37. In many small island contexts, the transmission and application of traditional knowledge is under threat from changes in consumption and migration patterns, as well as from the lack of recognition of traditional knowledge in the formal educational system.

Résumé exécutif

Lorsqu'on se penche sur le changement climatique, les peuples autochtones et les populations marginalisées méritent une attention particulière. Situés au sein d'environnements vulnérables – petites îles, zones de haute altitude, marges du désert ou Arctique circumpolaire – leurs territoires et leurs communautés sont soumis à un risque accru d'impacts à la fois précoces et sévères. En effet, le changement climatique menace directement de nombreuses sociétés autochtones qui s'appuient aujourd'hui encore sur des modes de subsistance où l'exploitation des ressources joue un rôle primordial. Mais leur forte exposition aux impacts négatifs ne justifie pas à elle seule l'attention et les préoccupations dont elles devraient faire l'objet. Etant donné que de nombreuses sociétés autochtones sont socialement et culturellement distinctes de la société majoritaire, les décisions, les politiques ou les actions mises en œuvre par cette majorité, même bien intentionnées, peuvent s'avérer inadéquates, mal adaptées, voire inappropriées. C'est pourquoi il est nécessaire de comprendre les vulnérabilités, les préoccupations, les capacités d'adaptation et les aspirations à long terme, spécifiques aux peuples autochtones et aux communautés marginalisées à travers le monde. Les savoirs autochtones et traditionnels contribuent à développer cette compréhension.

Cependant, les peuples autochtones et ruraux ne sont pas seulement des victimes potentielles du changement climatique mondial. L'attention qu'ils portent à leur environnement – sa variabilité, ses changements et ses tendances, fait partie intégrante de leurs modes de vie. Les savoirs locaux peuvent apporter des éclaircissements pertinents sur les transformations environnementales liées au changement climatique, et compléter les données scientifiques au niveau régional avec des précisions et des nuances à l'échelle locale. Les sociétés autochtones possèdent leurs propres stratégies d'adaptation pour faire face à des environnements instables. Certains ont même déjà amorcé un processus actif d'adaptation aux impacts précoces du changement climatique. Bien qu'on estime que les transformations liées au changement climatique sont sans précédent, les savoirs autochtones et leurs stratégies de réponse aux changements constituent un point d'appui fondamental pour développer les mesures d'adaptation au sein des communautés.

Les savoirs autochtones ont été reconnus dans le quatrième rapport d'évaluation (RE4) du Groupe d'experts intergouvernemental sur l'évolution du climat (GIEC), comme « une base inestimable pour développer les stratégies d'adaptation et de gestion des ressources naturelles en réponse aux changements, qu'ils soient environnementaux ou d'une autre nature» (GIEC, 2007). Cette reconnaissance a été réaffirmée lors de la 32ème session du GIEC (GIEC, 2010a), et la prise en compte des savoirs traditionnels et autochtones a été intégrée comme principe directeur au sein du Cadre de Cancún pour l'adaptation (CAF) adopté par les

Parties lors de la Conférence de la Convention Cadre des Nations Unies sur les Changements Climatiques à Cancún (CCNUCC, 2010). Au sommaire du cinquième Rapport d'Evaluation (RE5) du Groupe de Travail II du GIEC, les savoirs locaux et traditionnels apparaissent en tant que thème à part entière sous le chapitre 12 portant sur la sécurité humaine.

Ce rapport offre un aperçu de la littérature scientifique publiée (principalement la littérature révisée par les pairs mais aussi la littérature grise) portant sur la contribution des savoirs traditionnels et autochtones à notre compréhension du changement climatique mondial : observations, impacts et possibilités d'adaptation. Il porte essentiellement sur la littérature publiée après le RE4 et comporte aussi des éléments issus de la réunion internationale d'experts « Peuples autochtones, populations marginalisées et changement climatique : vulnérabilité, adaptation et savoirs traditionnels », qui s'est tenue à Mexico, Mexique du 19 au 21 juillet 2011.

Sans avoir la prétention d'être exhaustif, ce rapport a tout de même vocation à attirer l'attention sur les textes de référence, les sources de données clés et les sujets contentieux actuels. Voici une sélection des principaux points abordés.

Les savoirs autochtones comme soutien aux processus de prises de décisions

1. Les peuples autochtones vivent dans toutes les régions du monde et détiennent, occupent ou utilisent 22% des terres mondiales, qui elles-mêmes abritent 80% de la biodiversité mondiale. Bien qu'il n'existe pas qu'une seule façon de définir les peuples autochtones, un ensemble de critères principaux servent à identifier ce groupe très divers.

2. Les savoirs autochtones et traditionnels font référence aux savoirs et savoir-faire accumulés au cours des générations et renouvelés par chaque nouvelle génération et qui accompagnent les sociétés humaines dans leurs innombrables interactions avec l'environnement qui les entoure.

3. Malgré leur récente émergence dans les sciences du climat, les savoirs autochtones ont été largement reconnus dans des domaines comme l'agroforesterie, la médecine traditionnelle, la préservation de la biodiversité, la gestion traditionnelle des ressources, l'anthropologie appliquée, l'évaluation des impacts et la prévention des catastrophes naturelles.

4. Les observations et interprétations autochtones autour des phénomènes météorologiques accompagnent les activités saisonnières et inter-annuelles des communautés locales depuis des millénaires. Ces savoirs contribuent à la science du climat en proposant des observations et des interprétations

à une échelle spatiale bien plus précise et d'une profondeur temporelle considérable tout en mettant en évidence des éléments que les scientifiques spécialistes du climat ne prennent pas forcément en compte.

5. Les savoirs autochtones ciblent des éléments particulièrement importants pour assurer les modes de subsistance, la sécurité et le bien-être à échelle locale et par conséquent, s'avèrent essentiels à l'adaptation au changement climatique.

Savoirs autochtones, vulnérabilité et résilience

6. Les peuples autochtones et les populations marginalisées sont particulièrement exposés et vulnérables aux impacts du changement climatique. Cela s'explique à la fois par leurs modes de subsistance indissociables des ressources et par les environnements marginaux qui abritent leurs terres natales.

7. Leur faible densité de population, l'isolation et l'absence de droits reconnus sur leurs territoires et leurs ressources sont autant de facteurs contribuant à leur vulnérabilité face aux impacts économiques, sociaux et environnementaux, entraînés par des conditions climatiques changeantes.

8. Malgré cette exposition-vulnérabilité élevée, les peuples autochtones et les communautés locales réagissent de manière active aux conditions climatiques changeantes et font preuve d'une grande ingéniosité et de résilience face au changement climatique.

9. Les savoirs autochtones et les pratiques liées aux savoirs constituent les bases de la résilience autochtone.

10. Les stratégies qui consistent à entretenir la diversité des gènes et des espèces dans les champs et les troupeaux, permettent de minimiser l'impact des conditions météorologiques incertaines.

11. L'exploitation diversifiée des paysages, la mobilité et l'accès aux multiples ressources accroissent la capacité à répondre à la variabilité et au changement environnementaux et notamment au changement climatique.

12. Les systèmes traditionnels de gouvernance et les réseaux sociaux renforcent la capacité à répondre collectivement aux changements environnementaux et par conséquent accroissent la résilience.

13. Assurer l'égalité des genres au sein des politiques et des réponses face au changement climatique contribue au renforcement des capacités de résilience et d'adaptation.

14. Toutefois, le changement climatique ne représente qu'un facteur de changements parmi de nombreux autres. Ses effets ne peuvent être dissociés des multiples changements sociaux, politiques, économiques et environnementaux auxquels sont aujourd'hui confrontées les communautés autochtones et marginalisées. Ces impacts interagissent ensemble et déclenchent des réactions en chaîne aux effets aggravants.

Modes de subsistance traditionnels

15. Les modes de subsistance traditionnels sont le pilier d'une large proportion de la population mondiale. On estime que le pastoralisme se pratique sur 25% de la surface des terres mondiales et assure 10% de la production mondiale de viande. La plupart des pêcheurs à travers le monde pratiquent une pêche artisanale.

16. Les modes de subsistance traditionnels se pratiquent à petite échelle, de manière diversifiée et reposent sur un ensemble de compétences spécialisées. Maîtriser de multiples compétences associées à divers modes de subsistance renforce la résilience face à l'incertitude et au changement.

17. La diversification offre un bouclier contre la variabilité et le changement environnementaux. Les éleveurs nomades varient la composition spécifique et génétique au sein des troupeaux pendant que les agriculteurs à petite échelle pratiquent une gestion du risque à travers leur choix diversifié de cultures et de plantes domestiques, auxquelles s'ajoutent des réserves de ressources sauvages.

18. Les stratégies d'utilisation des terres constituent une autre source traditionnelle de résilience. Les peuples pastoraux déplacent leurs troupeaux en réponse aux conditions environnementales changeantes et réservent des zones de pâturage pour les années difficiles. Les agriculteurs pratiquant la culture sur brûlis mettent à profit les nombreuses ressources provenant des champs et des forêts à divers stades de mise en jachère et de régénération des terres.

19. Les politiques incitant à l'abandon des modes de subsistance traditionnels risquent d'ébranler la capacité des systèmes locaux basés sur les savoirs de répondre au changement environnemental.

Politiques et planification de l'adaptation

20. Les peuples autochtones connaissent une longue histoire d'interactions multi-générationnelles avec leur environnement, comme le fait de surmonter l'incertitude, la variabilité et les changements liés à l'environnement. Leur ingéniosité et leur capacité de réponse face au changement climatique mondial n'est plus à démontrer.

21. La résilience face au changement est ancrée dans les savoirs et savoir-faire autochtones, la diversification des ressources et des modes de subsistance, les institutions et réseaux sociaux ainsi que les valeurs et les attitudes culturelles.

22. Comprendre l'impact des politiques sur la résilience autochtone est indispensable à la création d'un environnement politique qui encourage les efforts communautaires d'adaptation en ouvrant les options et en soutenant l'innovation face à l'incertitude.

23. Certaines politiques gouvernementales ont des effets négatifs sur les capacités d'adaptation. En supprimant des options et en réduisant les choix, elles contraignent, restreignent et minent les efforts d'adaptation des communautés.

24. Parmi les politiques encourageant la résilience et l'adaptabilité, certaines ont pour but la protection de l'accès aux territoires traditionnels et leur intégrité, le renforcement des pratiques locales favorisant la diversité des cultures et des élevages ; l'amélioration de la transmission des savoirs, des valeurs, des comportements et des visions du monde autochtones.

25. Les processus de prise de décisions pour l'action autour du climat sont d'autant plus efficaces qu'ils rendent des comptes et répondent aux populations qui sont directement touchées, et qu'ils favorisent leur participation pleine et effective ainsi que leur représentation dans la gouvernance du climat.

26. Dans les domaines de la recherche et de l'adaptation au changement climatique, l'implication des peuples autochtones en tant que partenaires clés représente un défi majeur.

27. La collaboration entre les détenteurs des savoirs autochtones et les chercheurs scientifiques conventionnels génère de nouveaux savoirs, produits conjointement et relatifs aux actions d'adaptation effectives sur le terrain.

28. Un nombre croissant de peuples autochtones (en particulier dans les pays développés) s'engage dans la création de plans d'adaptation formels. Cependant, la planification et la recherche en matière d'adaptation ne sont pas distribuées de façon homogène à travers les régions.

Les Amériques : rapport régional

29. Dans les Amériques, le changement climatique a déjà profondément affecté les modes de subsistance des communautés autochtones.

30. Les savoirs autochtones relatifs au changement climatique – qu'ils concernent les techniques agricoles, la biodiversité, les indicateurs du

changement ou encore les techniques de prévision et de réponse aux conditions météorologiques – offrent des bases propices au développement de nombreuses mesures d'adaptation, à la fois efficaces et rentables.

31. La transmission des savoirs autochtones est menacée par des facteurs sociaux, culturels et environnementaux – changement climatique inclus – pouvant mener à l'érosion du corpus des connaissances et des réponses potentielles à apporter au changement climatique.

Région polaire Arctique et Pôle Nord : rapport régional

32. Les savoirs autochtones et les retours d'expérience directs des communautés arctiques constituent une base fondamentale pour la formulation de stratégies d'adaptation en lien avec cet environnement particulier.

33. Dans un environnement arctique particulièrement rude, les savoirs autochtones offrent une base pour la gestion du risque, la sécurité et les techniques de survie. La disparition de ces compétences parmi les jeunes générations est un sujet de préoccupation pour les plus anciens, accentué par l'imprévisibilité accrue des conditions météorologiques induite par le changement climatique.

34. Les communautés arctiques autochtones fournissent des observations systématiques des impacts du changement climatique. Ces observations viennent compléter les données scientifiques et offrent un cadre aux efforts d'adaptation à un niveau local.

Les petites îles : rapport régional

35. Dans les petites îles, les sociétés subissent de brusques bouleversements environnementaux depuis des générations. Les savoirs traditionnels et les pratiques qui s'y rapportent et grâce auxquels ces sociétés se sont adaptées à de tels changements peuvent s'avérer pertinents à l'échelle mondiale.

36. Les sociétés des petites îles ont développé des savoirs traditionnels liés à l'adaptation dans de nombreux domaines. Citons, entre autres : la préparation aux catastrophes naturelles, la réduction des risques, les systèmes de production alimentaire et les prévisions météorologiques.

37. Dans beaucoup de petites îles, la transmission et l'usage des savoirs traditionnels sont menacés par la modification des habitudes de consommation et l'évolution des flux migratoires, ainsi que par le manque de reconnaissance de ces savoirs par le système éducatif classique.

Resumen Ejecutivo

Al estudiar el cambio climático, los pueblos indígenas y las poblaciones marginadas merecen atención especial. Ya que se prevé que los efectos del cambio climático sobre sus territorios y comunidades serán graves y se afectarán primero pues se encuentran ubicados en entornos vulnerables, como pequeñas islas, regiones altas, márgenes desérticos y partes del Ártico circumpolar, El cambio climático es una amenaza directa para muchas sociedades indígenas puesto que su vida depende de los recursos locales. Sin embargo, su especial vulnerabilidad a las repercusiones negativas no constituye la única razón para suscitar preocupación y especial atención. Dado que muchas sociedades indígenas son social y culturalmente distintas de la sociedad dominante, las decisiones, políticas y acciones emprendidas por el grupo mayoritario, por muy bien intencionadas que sean, pueden resultar mal adaptadas, inadecuadas e inapropiadas. Existe, por lo tanto, la necesidad de entender las vulnerabilidades específicas, las preocupaciones, las capacidades de adaptación y de más largo plazo, las aspiraciones especificas de las comunidades indígenas y marginadas en todo el mundo. El conocimiento tradicional contribuye a esta visión más amplia.

No obstante, los pueblos indígenas y rurales son mucho mas que solo víctimas potenciales del cambio climático mundial. La atención a la variabilidad ambiental, los cambios y las tendencias medioambientales forman una parte integral de sus modos de vida. Sus conocimientos locales pueden proporcionar indicadores importantes de cambios medioambientales provocados por el cambio climático, y complementar, con precisiones y matices regionales, las investigaciones científicas a gran escala. Las sociedades indígenas han elaborado estrategias para hacer frente a entornos inestables, y en algunos casos, se han adaptando activamente a las repercusiones iniciales del cambio climático. Si bien se prevé que las transformaciones causadas por el cambio climático no tendrán precedentes, los conocimientos y las estrategias de respuesta indígenas brindan una base sólida para elaborar medidas de adaptación basadas en la comunidad.

En el Cuarto Informe de Evaluación del IPCC se reconoció que los conocimientos indígenas eran «una base irremplazable para desarrollar estrategias de adaptación y de gestión de los recursos naturales en respuesta a los cambios medioambientales y a otras formas de cambio». Este reconocimiento se reafirmó en la trigésima segunda reunión del IPCC en 2010 (IPCC-XXXII/Doc 7) y más recientemente el conocimiento tradicional/indígena fue incluido como principio rector para el Marco de Adaptación de Cancún por la CMNUCC/COP en 2011 (FCCC/CP/2010/7/Add.1, Párr. 12). En el esquema de la contribución

del Grupo de Trabajo II para el Quinto Informe de Evaluación del IPCC los conocimientos locales y tradicionales constituyen un tema por sí solo dentro del Capítulo 12 sobre Seguridad Humana.

El presente informe proporciona una descripción de la literatura científica publicada (principalmente la evaluada por expertos pero también incluye literatura gris) sobre las contribuciones del conocimientos tradicional y/o indígena a la comprensión científica del cambio climático global: observaciones, impacto y oportunidades para la adaptación. Se centra particularmente en la literatura posterior al IE4 y también incluye aportaciones de la reunión internacional de expertos «Pueblos indígenas, poblaciones marginadas y cambio climático: vulnerabilidad, adaptación y conocimientos tradicionales», celebrada del 19 al 21 de julio del 2011 en la Ciudad de México, México.

Si bien este informe no pretende ser exhaustivo, sí intenta subrayar la información esencial de base, las principales fuentes de datos y los ámbitos que siguen siendo objeto de debate. A continuación se presenta una selección de puntos claves.

Los Conocimientos Indígenas como Fundamento para la Toma de Decisiones

1. Los pueblos indígenas viven en todas las regiones del mundo y poseen, ocupan o utilizan recursos en aproximadamente 22% de la superficie terrestre, que a su vez alberga el 80% de la diversidad biológica del planeta. A pesar de que no existe una definición de pueblos indígenas, un conjunto básico de criterios sirve de orientación para identificar a este tan inmensamente diverso.

2. El conocimiento indígena o tradicional se refieren a los saberes generales y prácticos acumulados a través de generaciones, y actualizados por cada nueva generación, que orientan a las sociedades humanas en sus innumerables interacciones con su entorno.

3. Aunque apenas empieza a perfilarse en climatología, el conocimiento indígena ha sido ampliamente reconocido en otros ámbitos de la ciencia como la agrosilvicultura, la medicina tradicional, la conservación de la biodiversidad, la ordenación consuetudinaria de los recursos, la antropología aplicada, así como en la evaluación del impacto y respuesta ante desastres naturales.

4. Las observaciones e interpretaciones indígenas de los fenómenos meteorológicos han guiado las actividades estacionales e interanuales de las comunidades locales durante milenios. Estos conocimientos contribuyen al progreso de la climatología al ofrecer observaciones e interpretaciones

a una escala espacial mucho más reducida, que se extienden durante periodos considerables, y debido a que destacan elementos que podrían no ser tomados en cuenta por la climatología.

5. El conocimiento indígena se centra en elementos de importancia para la vida, la seguridad y el bienestar locales, y por lo tanto son esenciales para la adaptación al cambio climático.

Conocimiento Indígenas, Vulnerabilidad y Capacidad de Recuperación

6. Los pueblos indígenas y las poblaciones marginadas están particularmente expuestos y son sensibles al impacto del cambio climático debido a que dependen de medios de subsistencia obtenidos con recursos locales y a que sus tierras se localizan en entornos marginales.

7. Poblaciones reducidas, aisladas y la ausencia de derechos reconocidos sobre sus territorios y sus recursos pueden también contribuir a su vulnerabilidad a los impactos económicos y ambientales que produce el cambio climático.

8. A pesar de su alta exposición-sensibilidad, las comunidades indígenas y las comunidades locales, están respondiendo activamente a las condiciones climáticas cambiantes y han demostrado su capacidad de reacción y recuperación frente al cambio climático.

9. El conocimiento indígena y las prácticas de subsistencia basadas en el conocimiento local son los cimientos de la capacidad de recuperación indígena.

10. Estrategias tales como el mantenimiento de la diversidad genética y de la diversidad de las especies en sus campos y en sus rebaños desempeñan un papel amortiguante ante condiciones meteorológicas inciertas.

11. El uso diversificado del paisaje, la movilidad y el acceso a múltiples recursos aumentan la capacidad de reacción ante la variabilidad y el cambio medioambiental, incluyendo al cambio climático.

12. Los sistemas tradicionales de gobierno y de redes sociales contribuyen a la capacidad de responder colectivamente ante el cambio medioambiental y por lo tanto se aumenta la capacidad de recuperación.

13. La equidad de género en las políticas y las respuestas al cambio climático contribuyen para amplificar la capacidad de recuperación y adaptación.

14. El cambio climático es, sin embargo, solo uno de los muchos inductores de cambio. Los efectos del cambio climático no pueden desvincularse de los múltiples cambios sociales, políticos, económicos y medioambientales que afrontan actualmente las comunidades indígenas y marginadas. Estos impactos interactúan entre sí provocando efectos exacerbantes y efectos en cascada.

Modos de Vida Tradicionales

15. Los modos de vida tradicionales son el pilar de grandes segmentos de la población mundial. Se estima que el pastoreo se practica en el 25% de la superficie terrestre del planeta y proporciona el 10 % de la producción de carne a nivel mundial. La mayoría de los pescadores del mundo son artesanales.

16. Los modos de vida de subsistencia suelen ser de pequeña escala, diversificados y se basan en un cúmulo de habilidades especializadas. El dominio de las múltiples habilidades de sobrevivencia es un recurso para la capacidad de recuperación en tiempos de incertidumbre y cambio.

17. La diversificación proporciona un amortiguador frente a la variabilidad y el cambio medioambiental. Los pastores nómadas varían las especies y la composición genética de sus rebaños, mientras que los agricultores a pequeña escala gestionan el riesgo mediante su elección de cultivos domésticos y variedades vegetales, respaldados por las reservas de recursos naturales.

18. Las estrategias del uso de la tierra son otro recurso tradicional para la capacidad de recuperación. Los pueblos pastores desplazan sus rebaños en respuesta a condiciones medioambientales cambiantes y reservan por años ciertas áreas de pastoreo cuando las condiciones son extremas. Los agricultores(roza y quema?) itinerantes se benefician de los múltiples recursos de los campos y bosques en distintas etapas de barbecho y regeneración.

19. Las políticas que proporcionan incentivos para abandonar los medios de vida tradicionales pueden poner en peligro la capacidad de recuperación, ante los cambios medioambientales, de estos sistemas basados en el conocimiento local.

Políticas de Adaptación y Planificación

20. Las comunidades indígenas poseen historias largas y multigeneracionales de interacción con sus entornos que incluyen: enfrentar a la incertidumbre, a la variabilidad y a los cambios medioambientales. Las comunidades indígenas ya han demostrado su ingenio y capacidad de respuesta frente al cambio climático.

21. La capacidad de recuperación frente al cambio está estrechamente vinculada a el conocimiento y prácticas indígenas, a los recursos y los medios de vida diversificados, a los modos de vida tradicionales mencionados en los párrafos 14 al 18.

22. La comprensión de cómo las políticas pueden afectar la capacidad de recuperación es clave para crear políticas que apoyen los esfuerzos de adaptación de la comunidad ofreciéndoles opciones y fomentando la innovación frente a la incertidumbre.

23. Desafortunadamente, muchas de las políticas gubernamentales tienen efectos negativos. Pues eliminan opciones y reducen alternativas, restringen, limitan y socavan los esfuerzos de adaptación de la comunidad.

24. Las políticas que apoyan la capacidad de recuperación y la adaptabilidad son aquéllas que mantienen la integridad y el acceso a los territorios tradicionales, que refuerzan las prácticas locales, que respaldan la diversidad de cultivos o de rebaños y que mejoran la transmisión de los conocimientos, los valores, las actitudes y las visiones del mundo indígena.

25. Los procesos de toma de decisiones deben de responder y ser receptivos a los pueblos que son afectados y a la vez ofrecerles apoyo para que participen plena y efectivamente en la gobernabilidad del cambio climático.

26. Es un gran reto garantizar la participación de los pueblos indígenas como socios clave en el desarrollo tanto de la investigación sobre el cambio climático como en los planes de adaptación.

27. La colaboración entre los portadores del conocimiento indígena y la investigación científica convencional está generando nuevo conocimiento necesario para realizar una labor de adaptación eficaz en el terreno.

28. Un número creciente de pueblos indígenas (particularmente en los países desarrollados) se esta moviendo hacia la creación de planes de adaptación formales.

Las Américas: Informe Regional

29. El cambio climático ya está afectando gravemente la vida de los pueblos indígenas en las Américas.

30. Los conocimientos indígenas referentes al cambio climático – ya sea de técnicas agrícolas, de biodiversidad, de indicadores de cambio o de

predicciones meteorológicas y respuestas – constituye la base para muchas medidas de adaptación acertadas y económicamente rentables.

31. La transmisión del conocimiento indígena se ve amenazada por factores sociales, culturales y medioambientales incluyendo el cambio climático, lo que da como resultado la erosión de la base del conocimiento y de su potencial para responder al cambio climático.

Regiones Polares Árticas/Septentrionales: Informe Regional

32. El conocimiento indígena y las experiencias de primera mano de las comunidades árticas son una base esencial para la formulación de estrategias de adaptación pertinentes a nivel local.

33. En los difíciles entornos árticos, los conocimientos indígenas proporcionan la base para la gestión de riesgos, así como seguridad y aptitudes de supervivencia. La erosión de estas competencias en las nuevas generaciones es una preocupación para los ancianos dado el incremente en la imprevisibilidad de las condiciones meteorológicas debido al cambio climático.

34. Las comunidades indígenas del Ártico están proporcionando observaciones sistemáticas de los efectos del cambio climático, que complementan los datos científicos y enmarcan los esfuerzos locales de adaptación.

Pequeñas Islas: Informe Regional

35. Muchas sociedades insulares han vivido durante generaciones, con considerables cambios medioambientales y a menudo repentinos. El conocimiento tradicional y las prácticas vinculadas con lo que las sociedades insulares se han ido adaptando, son de importancia a nivel mundial.

36. Entre los ámbitos en que las sociedades insulares han desarrollado conocimiento tradicional relevante a la adaptación, figuran la preparación para los desastres naturales, la reducción de riesgos, los sistemas de producción de alimentos y el pronóstico de tiempo.

37. En muchos contextos insulares, la transmisión y la aplicación del conocimiento tradicional se ve amenazada por cambios en los patrones de consumo y la migración, así como por la falta de reconocimiento del conocimiento tradicional dentro del sistema educativo formal.

Chapter 1. Introduction

1.1. Background and rationale

The Intergovernmental Panel on Climate Change (IPCC), an international scientific body mandated to provide the world with a clear understanding of climate change and its potential environmental and socio-economic impacts, publishes Assessment Reports on topics relevant to the implementation of the UN Framework Convention on Climate Change (UNFCCC). These reports are based primarily on published and peer-reviewed scientific literature and are among the most widely cited sources in debates related to climate change.

The IPCC's Fourth Assessment Report (AR4) noted that 'indigenous knowledge is an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change' (Parry et al., 2007). This recognition was reaffirmed at the 32nd Session of the IPCC in 2010: 'indigenous or traditional knowledge may prove useful for understanding the potential of certain adaptation strategies that are cost-effective, participatory and sustainable' (IPCC, 2010a). Finally, the Cancun Adaptation Framework (CAF), adopted by Parties at the 2010 United Nations Framework Convention on Climate Change (UNFCCC) Conference in Cancun, has as a guiding principle, the need for adaptation to be 'based on and guided by the best available science and, as appropriate, traditional and indigenous knowledge'. It also calls for adaptation action to 'take into consideration vulnerable groups, communities and ecosystems' (UNFCCC, 2010, para. 12).

Like previous assessment reports, the outline for the IPCC's Fifth Assessment Report (AR5), to be published in 2014, was developed through a scoping process that involved climate change experts from all relevant disciplines, government representatives and other interested stakeholders. With respect to the outline that was adopted during the 31st IPCC session in Bali, 26-29 October 2009, the IPCC specifically notes that 'Chapters 14–17 will include case studies of, for example, Least Developed Countries, indigenous peoples and other vulnerable countries and groups' (IPCC, 2010b) and that Chapter 12 on human security will include a section on 'local and traditional knowledge'.

Up until now, observations and assessments by indigenous peoples and local communities have remained largely outside the IPCC process, in part due to the formal requirement of scientific documentation and peer-reviewed publication.

In recent years, however, collaborative research bringing together indigenous peoples and natural and social scientists has led to a growing volume of published materials in the scientific literature. Documentation in grey literature and non-written media has also grown, although these sources have traditionally remained outside the scope of IPCC assessments. All of these efforts have contributed to an increasing realization that the observations and assessments of indigenous peoples and local communities offer valuable *in situ* information, provide for local verification of global scientific models and satellite data sets, and ensure that adaptation measures align with local needs and priorities.

In accordance with CAF guiding principles, AR5 is expected to include strengthened content related to indigenous knowledge, and to consider the specific circumstances of vulnerable groups, including indigenous peoples. This publication contributes to this objective, which some have qualified as particularly challenging (Ford, Vanderbilt and Berrang-Ford, In press).

1.2. Scope of the report

A number of international agencies with expertise in traditional, local and indigenous knowledge have been working to support consideration of this knowledge in the AR5, as well as vulnerable groups such as indigenous peoples. The IPCC, the Secretariat of the Convention on Biological Diversity (SCBD), the United Nations Development Programme's GEF Small Grants Programme (UNDP/GEF SGP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the United Nations University (UNU) convened an international expert meeting entitled 'Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge' from 19 to 21 July 2011 in Mexico City to further explore this topic. Overseen by an international panel of experts, the meeting brought together indigenous peoples and natural and social scientists from both developed and developing countries with lead authors and the Chair of AR5 Working Group II.

This Technical Report provides an overview of relevant published sources in the scientific and grey literature, and includes information from the international expert meeting in Mexico. It aligns some of the key issues that emerge from these sources with themes identified in the outline of the AR5 Working Group II report. Due to limitations of resources and time, only a selection of themes from the AR5 outline could be covered in this Technical Report. This does in no way mean that themes and regions that are not addressed are of lesser importance, nor without valuable research results on indigenous knowledge and climate change.

1.3. Structure of the report

Topics addressed in this report include:[1]

- Key concepts for the AR5 chapters on *Foundations for decision-making* and *Human security*, as they relate to: identifying *indigenous peoples*; conceptualizing *local and traditional knowledge*; and understanding their contributions to understanding climate change *risks, vulnerabilities and opportunities*, as well as *adaptation* (Chapter 2);

- The need to analyse *vulnerability* in terms of exposure, sensitivity and capacity to respond, and thus bring recognition to the *resilience* of indigenous peoples and local communities and the role of traditional and indigenous knowledge (Chapter 3);

- Case studies of the impacts of climate change on traditional *livelihoods* and the adaptation opportunities rooted in traditional and indigenous knowledge and practice (Chapter 4);

- The emerging role for *adaptation planning and implementation* to optimize the adaptive capacities of communities by reinforcing their endogenous resilience based on indigenous knowledge, practices and coping strategies, while avoiding policies that constrain and undermine traditional response capacities. *Knowledge* transmission and co-production, as well as land tenure and cultural diversity are also considered in this context (Chapter 5).

The report also includes:

- A regional report covering *North America* and *Central and South America* (Chapter 6);

- A regional report covering the Arctic/Northern *Polar Regions* (Chapter 7);

- A regional report on *Small Islands* (Chapter 8);

- Conclusions (Chapter 9).

1 *AR5 chapter headings and sub-headings are given in italics.*

Chapter 2. Indigenous Knowledge as a Foundation for Decision-Making

Key points

- Indigenous peoples live in all regions of the world and own, occupy or use resources on some 22% of the global land area, which in turn harbours 80% of the world's biological diversity. While there is no single definition for indigenous peoples, a core set of criteria guide the identification of this highly diverse group.

- Indigenous or traditional knowledge refers to the knowledge and know-how accumulated across generations, and renewed by each new generation, which guide human societies in their innumerable interactions with their surrounding environment.

- Although nascent in climate science, indigenous knowledge has been widely recognized in fields such as agroforestry, traditional medicine, biodiversity conservation, customary resource management, applied anthropology, impact assessment and natural disaster preparedness and response.

- Indigenous observations and interpretations of meteorological phenomena have guided seasonal and inter-annual activities of local communities for millennia. This knowledge contributes to climate science by offering observations and interpretations at a much finer spatial scale with considerable temporal depth, and by highlighting elements that may not be considered by climate scientists.

- Indigenous knowledge focuses on elements of significance for local livelihoods, security and well-being, and as a result is essential for climate change adaptation.

2.1. Overview

In the face of global climate change and its emerging challenges and unknowns, it is essential that decision-makers base policies and actions on the best available knowledge. The bio-physical and social sciences contribute significantly to the collective understanding of earth systems, social systems and their interactions. However, in recent years there has been a growing awareness that scientific knowledge alone is inadequate for solving the climate crisis (Finucane, 2009). In particular, the knowledge of local and indigenous peoples – often referred to as local, indigenous or traditional knowledge – is increasingly recognized as an important source of climate knowledge and adaptation strategies. Indigenous knowledge is already seen as pivotal in fields such as sustainable development, agroforestry, traditional medicine, applied anthropology, biodiversity conservation and natural resource management, and many are expecting this knowledge to play a prominent role in climate science and in facilitating adaptation to climate variability and change.

This chapter provides an overview of basic definitions and key concepts in the field of local, indigenous and traditional knowledge and its role in climate science and decision-making. It provides brief illustrations of the long history of interaction between scientific and traditional knowledge, and presents a few case studies of how indigenous knowledge has influenced environmental decision-making during recent decades. It suggests that the integration of local, traditional and indigenous knowledge in climate science would result in the mutual enrichment of both knowledge systems, and the reinforcement of on-the-ground solutions.

2.2. Identifying 'indigenous peoples'

Indigenous peoples live in all regions of the world and own, occupy or use up to 22% of the global land area, which in turn harbours 80% of the world's biological diversity (UNDP, 2011: 54). They are estimated to number some 370 million people, and represent the greater part of the world's cultural diversity (UNPFII, n.d.), including the major share of the world's almost 7000 languages (Harrison, 2007).

In view of the enormous cultural diversity of indigenous peoples, their diverse histories of contact and interaction with other societies, and the broad spectrum of political contexts in which they live, establishing a universally accepted definition of 'indigenous peoples' has never been a simple matter. Most operational definitions, however, converge around a set of core criteria that generally include:

- Maintenance of social and cultural traits distinct from those of mainstream or dominant society (which may include distinct languages, production systems, social organization, political and legal systems, spirituality and worldviews, among other aspects);

- Unique ties to ancestral territories and to the natural resources of these places;

- Self-identification and recognition by others as being part of a distinct cultural group (Cobo, 1986);

- In many instances, reference is also made to a historical or continuing experience with subjugation, dispossession and marginalization.

Terms used to designate indigenous peoples vary considerably with place, social context and historical moment. Native, aboriginal or tribal peoples, hill tribes, scheduled tribes, sea gypsies, Indians, bushmen, First Nations or ethnic minorities are only a few of the many terms that may be applied to indigenous peoples. Other names are more clearly derogatory such as savages, primitives or 'indigenes' (as opposed to the more neutral French term 'autochtones'). Some members of indigenous groups may hide their identity due to the negative connotations of the 'indigenous label' in some countries and contexts (Montenegro and Stephens, 2006).

Many groups that self-identify as indigenous peoples are not recognized as such by the countries in which their homelands exist. Many indigenous homelands extend across national borders, and in some cases a single people may find themselves divided among several countries (UNPFII, n.d.).

2.3. Indigenous, traditional or local knowledge

The terms 'indigenous, traditional or local knowledge' make reference to knowledge and know-how accumulated across generations, which guide human societies in their innumerable interactions with their surrounding environment. Berkes defines such traditional ecological knowledge as: 'a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment' (2012: 7).

These knowledge systems are transmitted and renewed by each succeeding generation, and ensure the well-being of people around the globe by providing food security from hunting, fishing, gathering, pastoralism or small-scale agriculture, as well as healthcare, clothing, shelter and strategies for coping with environmental fluctuations and external forces of change (Warren, Slikerveer and Brokensha 1995; Sillitoe, Bicker and Pottier, 2002; Nakashima and Roué, 2002; Sillitoe, 2007).

An abundance of labels for this knowledge co-exist in the literature. Common terms include but are not limited to indigenous knowledge, traditional knowledge, traditional ecological knowledge (TEK), local knowledge, farmers' knowledge, folk knowledge and indigenous science. Although each term may have somewhat different connotations and reference groups, they often share sufficient meaning to be utilized interchangeably in many contexts (Berkes, 2012; Nakashima and Roué, 2002). For the sake of simplicity, the terms traditional, indigenous or local knowledge are used interchangeably throughout this technical report. While many of the examples put forward relate to knowledge developed and maintained by indigenous peoples, it should be kept in mind that valuable local knowledge of relevance for climate change assessment and adaptation is also held in non-indigenous, rural societies (Grabherr, 2009; Lawrence, 2009).

Another consideration is that traditional knowledge is often gendered (Berkes, 2012). Although men and women share knowledge, they also hold distinct knowledge sets relating to differing and complementary roles in society and in production. Rocheleau (1991) comments that 'half or more of indigenous ecological science has been obscured by the prevailing 'invisibility' of women, their work, their interests and especially their knowledge.' In her documentation of knowledge of indigenous men and women, Helen Clifton, an Elder of the Gitgathe Nation, British Columbia, Canada, notes that women's tasks may be weather-dependent including the cutting and drying of halibut and the processing of edible seaweed (Turner and Clifton, 2009).

This report uses the term 'knowledge' in its broadest sense. In Occidental cultures, knowledge (in particular, scientific knowledge) is presented in opposition to practice (science vs. technology) and the rational is presented in opposition to the spiritual (science vs. religion). In indigenous worldviews, however, these elements are combined in a holistic understanding of interaction with the surrounding environment. Indigenous knowledge thus encompasses not only empirical understandings and deductive thought, but also community know-how, practices and technology; social organization and institutions; and spirituality, rituals, rites and worldview. For the purposes of this report, knowledge, when labelled as traditional, indigenous or local, marries the functional with the symbolic, and interlinks complexity, versatility and pragmatism (Nakashima and Roué, 2002).

Indigenous knowledge has already made substantial contributions in many fields: biodiversity conservation and wildlife management (Freeman and Carbyn, 1988; Inglis, 1993; Berkes, 2012), customary marine resource management (Johannes, 1978; 2002; Hickey, 2006; Haggan, Neis and Baird, 2007), rural development and agroforestry (Falanruw, 1989; Scoones and Thompson, 1994; Sillitoe, Bicker and Pottier, 2002), traditional medicine and health (Ford et al., 2010; Pourchez, 2011), impact assessment (Sadler and Boothroyd, 1994; Usher, 2000); and natural disaster preparedness and response (Shaw, Uly and Baumwall, 2008). Some of this work is profiled in the following section.

2.4. Indigenous knowledge and science: a brief history

While indigenous knowledge is an emerging area of interest for climate scientists, the exchange of knowledge between scientists and indigenous peoples dates back to the very origins of science. This sub-section provides four brief snapshots that illustrate the nature of this interaction and the relatively recent emergence of contemporary understandings of the breadth, depth and diversity of indigenous peoples' knowledge of the natural world.

Colonial science borrows from indigenous knowledge

Traditional knowledge is as ancient as humankind, and it is in traditional knowledge that the origins of science are rooted. In the seventeenth and eighteenth centuries, with European colonial expansion, the newly established scientific disciplines of ethnobotany and ethnozoology thrived on an influx of new knowledge from traditional knowledge holders across the globe. Their primary mission, however, was not to understand these other knowledge systems *per se*, but rather to glean from them information for the development of colonial science. Their efforts focused on compiling lists of 'useful' plants and animals unknown to European science.

However, scientists during the colonial period did not limit their reliance on local experts to the simple identification of species of interest. They adopted from indigenous peoples entire classification schemes that order and interpret ecological systems according to an indigenous logic. In this manner, Western taxonomic knowledge and practice were significantly transformed by their encounter with traditional systems of knowledge and meaning. For example, European understandings of Asian botany 'ironically, depended upon a set of

diagnostic and classificatory practices, which though represented as Western science, had been derived from earlier codifications of indigenous knowledge' (Ellen and Harris, 2000: 182). Throughout the colonial period, Western scientific understandings expanded through the appropriation of traditional ecological knowledge, with little acknowledgment of the intellectual origins of their borrowed discoveries.

Ground-breaking research on indigenous ecologies of tropical plants

A shift in the attitudes of Western scientists towards indigenous knowledge began in the mid-twentieth century, triggered by the iconoclastic work of Harold Conklin, an American anthropologist who worked in the Philippines and authored *The Relations of Hanunoo Culture to the Plant World* (Conklin, 1954). Conklin observed that in Hanunoo society, 'the hundreds of characteristics which differentiate plant types and often indicate significant features of medicinal or nutritional value', were a major topic of everyday conversation (Conklin, 1954: 97). This empirical interest in plants is acquired very young, as demonstrated by Conklin's account of his exchange with a 7-year-old Hanunoo girl. She systematically examined Brown's authoritative three-volume guide to useful plants of the Philippines, and for each image, she either assigned a Hanunoo name or solemnly declared to have 'not seen that plant before'. Out of 75 plants, she identified 51 with only two errors (Conklin, 1954). Conklin's work documents indigenous ways of understanding and knowing the world – specifically the plant world – and began to raise questions about the supposedly superior intellect and training of scientists by demonstrating the complexity, detail and accuracy of indigenous knowledge and its value for the scientific community (Schultes, 1994; Zent, 2009). Anthropologists also contributed to this changing outlook on indigenous knowledge. In his widely cited work *The Savage Mind*, Claude Levi-Strauss (1962) argued that indigenous knowledge is first and foremost an intellectual pursuit, debunking prevailing stereotypes of traditional thought as limited to the functional.

'Eskimo is a scientist'

The polar sea ice environment figures prominently in global climate change debates. More than four decades ago, Richard Nelson (1969) documented indigenous knowledge of this critical milieu in great detail. Extending well beyond an investigation of survival techniques for a harsh environment, Nelson describes the sophistication and meticulous detail of Inuit hunter knowledge of snow and ice regimes. This trail-blazing research laid the foundations for recent investigations of climate change impacts on snow-ice environments

across the circumpolar North within the framework of the International Polar Year (Krupnik et al., 2010).

Nelson provides a revealing account of one hunting experience. Following a young Inuk to the sea ice edge in early winter, he witnessed how an experienced hunter combines an intimate knowledge of seal behaviour, with traditional and modern technology and techniques, to produce a successful hunting outcome. His young companion summed it up by declaring: 'You see, Eskimo is a scientist'. After several years of research, Nelson concluded: 'Indeed, the Eskimo is a scientist, one whose major concern is discovering the secrets of the environment and of the animals that live in it. … What may seem unfathomable to us at first is often so only because we lack knowledge and understanding' (Nelson, 1969: xxii–xxiii).

Customary marine resource management in the Pacific Islands

Robert Johannes conducted groundbreaking work in the mid-1970s on indigenous knowledge in the small island developing states of the Pacific (Johannes, 1978). His overview of traditional marine conservation institutions and practices in Oceania led him to conclude that 'almost every basic fisheries conservation measure devised in the West was in use in the tropical Pacific centuries ago' (Johannes, 1978: 352). This iconoclastic contribution opened the way for decades of research into the knowledge of indigenous, artisanal and commercial fishers, and these data have offered science invaluable insights into 'stock structure, inter-annual variability in stock abundance, migrations, the behaviour of larval/post-larval fish, currents and the nature of island wakes, nesting site fidelity in sea turtles, spawning aggregations and locations, local trends in abundance and local extinctions' (Johannes and Neis, 2007: 41). Johannes' own work with fishers in the archipelago of Palau led to the documentation of 'the months and periods as well as the precise locations of spawning aggregations of some 55 species of fish that followed the moon as a cue for spawning' (Berkes, 2012). This local knowledge more than doubled the number of fish species known to science that exhibit lunar spawning periodicity (Johannes, 1981).

While Johannes' first paper in the *Annual Review of Ecological Systems* in 1978 expressed concern for the demise of traditional conservation, 24 years later, he wrote in the same scientific journal a rebuttal to his earlier paper that welcomed 'The renaissance of community-based marine resource management in Oceania' (Johannes, 2002).

2.5. Correlating observations from indigenous and scientific sources

The contemporary study of indigenous knowledge and its interface with science stretches back over five decades. The numerous case studies published in the scientific literature demonstrate the breadth and sophistication of the knowledge possessed by indigenous experts about their natural milieu. Much research has focused on the knowledge elaborated by societies worldwide regarding biological diversity (in particular plants and animals) and their related ecosystems and production systems (e.g. hunting, fishing, herding, agriculture etc.), including customary institutions for the management of resource access and exploitation.

Some investigations have also been dedicated to the physical environment, for example, Inuit and Sami knowledge of snow and ice (Nelson, 1969; Magga, 2006), and Pacific Islander knowledge of ocean currents, swell patterns, winds, tides, the reflection and diffraction of waves, the movements of constellations, and other phenomena related to open ocean navigation (Finney, 1994; Lewis, 1972). However, until recently, relatively little work has focused on indigenous observations and understandings of weather and climate. One noteworthy exception is the trailblazing work undertaken by Orlove et al. (2000, 2002) on Andean ethnoclimatology, in particular, the ritual observation of the Pleiades constellation undertaken immediately after the winter solstice by indigenous farmers of the Peruvian and Bolivian Andes. On the basis of these observations, villagers forecast the timing and quantity of rains, as well as the size of the harvest, for the following year. If the star cluster appears relatively large and bright, then rainfalls will be abundant and harvests substantial, while a small and dim appearance anticipates poor rains. In the latter case, farmers delay the planting of potatoes, their most important crop. Historically documented for more than 400 years, this traditional climate forecasting ritual in fact enables villagers to identify El Nino years, which are also linked to diminished precipitation. Orlove et al. were able to demonstrate how and why these ancient observations actually work:

> *The apparent size and brightness of the Pleiades varies with the amount of thin, high cloud at the top of the troposphere, which in turn reflects the severity of El Niño conditions over the Pacific. Because rainfall in this region is generally sparse in El Niño years, this simple method provides a valuable forecast, one that is as good or better than any long-term prediction based on computer modeling of the ocean and atmosphere.*
>
> (Orlove et al., 2002: 428)

In recent years, climate change, local communities and indigenous peoples have become a rapidly expanding area of joint investigation involving social scientists, notably anthropologists, climate scientists and indigenous peoples. As one indicator of this trend, Roncoli, Crane and Orlove (2009) list 192 published papers in a recent review of epistemological and methodological approaches to climate change in cultural anthropology, while Crate (2011) references 136 sources on climate and culture in an article for the *Annual Review of Anthropology*. Looking specifically at farmers' responses to climate predictions, Roncoli (2006) surveyed 154 references. In this area of work, the Arctic region has been a forerunner, with the 1000-page *Arctic Climate Impact Assessment Report* incorporating traditional knowledge in its design from the outset (ACIA, 2005). Already in 2005, the ACIA Chapter on 'Indigenous Perspectives' on a changing Arctic made reference to 134 published sources (Huntington et al., 2005). More recent regional reviews of the scientific and grey literature on climate change adaptation planning for the western Canadian Arctic cite 140 references (Pearce et al., 2011), while Ford et al. (In press) cover 162 references in their literature review of human dimensions of climate change research for the central and eastern Canadian Arctic.

Based on traditional knowledge of weather patterns and climatic conditions, indigenous peoples in many parts of the world are increasingly reporting that weather and climate are changing. Such observations have been recorded for indigenous peoples around the world, for example, in the Arctic (e.g. Krupnik and Jolly, 2002; Nichols et al., 2004; Oozeva et al., 2004; Gearheard et al., 2006; Vlassova, 2006; Laidler et al., 2009; Aporta and MacDonald, 2011), Africa (e.g. Ovuka & Lindqvist, 2000; West et al., 2008;), Asia (e.g. Raj, 2006; Crate, 2008; Marin, 2010) and North America (e.g. Turner and Clifton, 2009; Jacob et al., 2010).

In the Arctic, where accelerated global warming is well-documented, community members report that the weather is not behaving as it used to (Berkes and Jolly, 2001; Krupnik and Jolly, 2002). Since the advent of the 1990s, they have found conditions to be much more variable and as a result, they can no longer forecast weather as before. This represents a worrisome state of affairs for hunting people who travel great distances in environments that can become treacherous, even life threatening. Indeed, Gearheard et al. (2010) report that today, hunters from Clyde River, Arctic Canada, often carry extra gear when they go out on the land, because they are conscious of the heightened unpredictability of weather and the increased risk of being caught by a sudden storm or blizzard.

Scientific efforts to confirm these reports from Arctic residents have not always met with success. Gearheard et al. (2010), for example, document Inuit observations that weather and wind conditions have become more

variable and unpredictable, that the prevailing wind direction has changed, and that winds are stronger and more constant than in the past. Yet, when these indigenous observations are compared with wind data from the local meteorological station in Clyde River, the quantitative time-series data since 1977 do not uphold observations made by Inuit. Data from other climate studies are equally at odds with indigenous observations. Gearheard persisted, however, and in tandem with a meteorological expert generated thought-provoking results. Their analysis of weather 'persistence' – described as the likelihood that an exceptionally warm day will be followed by another such day, unveils a significant drop in weather persistence in the spring that begins some 20 years ago (Weatherhead, Gearheard and Barry, 2010). These data coincide with Inuit observations that, starting in the 1990s, the weather has become more difficult to predict, particularly so in the spring season.

While additional investigations are required, the two studies offer interesting insights into the nature of both indigenous and scientific knowledge. First, even though indigenous peoples and scientists may seem on the surface to be observing the same phenomenon in the same environment (e.g. weather in the Arctic), in actual fact the nature of their observations may quite profoundly differ (Nichols et al., 2004). Indigenous observers base their conclusions on multiple environmental and social factors that they consider in an integrated manner (e.g. wind speed, direction and variability, combined with temperature and precipitation, as well as the need for shelter and safety when travelling with or without family). In contrast, scientists may isolate a single environmental variable (e.g. temperature or wind speeds) and reach broader conclusions based upon an extrapolation from this narrow data set (Weatherhead, Gearheard and Barry, 2010). Furthermore, climate scientists often focus their attention on mean values (e.g. mean wind speed), while the primary preoccupations of indigenous observers of weather may be the intensity and frequency of peaks and lows (Weatherhead, Gearheard and Barry, 2010). In other words, efforts to compare indigenous and scientific knowledge of a phenomenon may amount to comparing apples and oranges.

The two papers illustrate the inherent difficulties of corroborating the observations of indigenous people and scientists. While scientists may first tend to attribute shortcomings to the indigenous knowledge data (i.e. unsystematic observations, lack of quantitative method, inaccurate data collection, etc.), in actual fact, numerous shortcomings may relate to the practice of science (i.e. a reductionist approach with consideration of too few variables, inappropriate choice of parameters to be measured, abusive extrapolation from data of limited scope).

Marin (2010) comes to similar conclusions from work with nomadic pastoralists in Mongolia, where indigenous observations diverge and are even contradicted by meteorological records and predictions. As in the Inuit case outlined above, parameters recorded by scientists, such as absolute measures of rainfall, are not appropriate nor subtle enough to detect changes of significance for herders, such as increased patchiness of rainfall (referred to as 'gan' or silk embroidery rain) and an increase in hard rains that run-off instead of penetrating into the soil (Marin, 2010: 167).

Faced with the challenge of climate change and the numerous unknowns ahead, efforts to create a constructive dialogue between indigenous peoples and scientists constitute an important step towards decision-making based on the best available knowledge.

Chapter 3. Indigenous Knowledge, Vulnerability and Resilience

Key points

- Indigenous peoples and marginalized populations are particularly exposed and sensitive to climate change impacts due to their resource-based livelihoods and the location of their homelands in marginal environments.
- Small population size, isolation, and the absence of recognized rights over their territories and resources may also contribute to their vulnerability to economic, social and environmental impacts brought about by a changing climate.
- Despite their high exposure-sensitivity, indigenous peoples and local communities are actively responding to changing climatic conditions and have demonstrated their resourcefulness and resilience in the face of climate change.
- Indigenous knowledge and knowledge-based practice are the foundations of indigenous resilience.
- Strategies such as maintaining genetic and species diversity in fields and herds provide a low-risk buffer in uncertain weather environments.
- Diversified use of the landscape, mobility and access to multiple resources increase the capacity to respond to environmental variability and change, including climate change.
- Traditional systems of governance and social networks contribute to the ability to collectively respond to environmental change and thus heighten resilience.
- Gender equality in climate change policies and responses contributes to enhanced resilience and adaptive capacity.

- Climate change, however, is only one of many drivers of change. Its effects cannot be isolated from the multiple social, political, economic and environmental changes confronting present-day indigenous and marginalized communities. These impacts interact together and induce exacerbating and cascading effects.

3.1. Overview

It has become common currency to argue that indigenous peoples are particularly vulnerable to climate change due to their dependence upon resource-based livelihoods and the location of homelands in marginal habitats, such as polar regions, desert margins or high altitude areas. It has also been argued, however, that indigenous livelihoods are resilient because they rely upon multiple resources and a diversity of crops and crop varieties, whereas specialization on single resources and mono-cultures with high capital investment render 'modern' systems particularly vulnerable. This chapter examines how the terms vulnerability and resilience are defined and deployed in the framework of climate change debates, and how traditional knowledge and practice may reduce vulnerability and reinforce resilience among indigenous peoples.

3.2. Context and concepts: vulnerability and resilience

The ability of systems to adapt to global climate change is often discussed in terms of resilience and vulnerability. In the AR4, the IPCC (2007) defines vulnerability as 'the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes'. Adger (2006: 268) defines vulnerability as 'the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt'. Both of these definitions emphasize the importance of two factors: exposure to stress and inability to cope.

The IPCC (2007) further points out that 'those in the weakest economic position are often the most vulnerable to climate change and are frequently the most susceptible to climate-related damages, especially when they face multiple stresses'. In this respect, specific reference is made in the AR4 to indigenous peoples and traditional ways of living, particularly in Polar Regions and small island states.

Current research on vulnerability to climate change suggests that indigenous communities are among those who suffer the most from the economic, social and environmental stresses triggered by a changing climate, in part due to small population sizes, isolation, and the absence of recognized rights over their territories and resources (Ribot et al., 1996; Adger and Kelly, 2001; Adger et al., 2004). In addition, they rely on biological, ecological, cultural and social assets (including traditional and indigenous knowledge) for their livelihoods, which furthermore depend on the balancing of societal, natural and spiritual realms (Kronik and Verner, 2010a).

Yet, indigenous peoples rarely represent themselves as helpless or unable to cope in the face of climate change (Salick and Byg, 2007; Salick and Ross, 2009; Berkes and Armitage, 2010). Even though Inuit have expressed grave concerns about climate change impacts on their homelands, they have also systematically expressed confidence in their ability to adapt to whatever circumstances climate change may bring (Cochran, 2008; Lynge, 2011). Retter (2009) contrasts the resilience of the diversified and ecosystem-based fishing economies of the indigenous Sea Sami, with the vulnerability of Norwegian commercial fisheries that rely solely on cod, a species that some speculate may move northwards out of the Norwegian economic zone as ocean waters continue to warm.

It is important to emphasize that even when indigenous peoples make detailed observations of changes in weather and ecological responses, they do not always register alarm. For example, nomadic Nenets reindeer herders of the Russian Arctic, whose annual migration over hundreds of kilometres takes place entirely at or north of the latitudinal treeline, have in recent decades observed the symptoms attributed by scientists to a warming climate, such as later freeze up in autumn, earlier thaw in spring, and warmer winters characterized by more frequent and intense rain-on-snow events (Forbes and Stammler, 2009; Bartsch et al., 2010). The latter can result in ice encrusted pastures and significant losses (up to 25%) of herds (Bartsch et al., 2010). Yet, so far, herders feel that this variation in weather does not represent a trend and does not endanger their survival for the foreseeable future, relative to massive hydrocarbon extraction on their traditional territories (Rees et al., 2008; Forbes et al., 2009; Forbes and Stammler, 2009; Kumpula et al., 2012).

Consequently, more circumspect use of the term 'vulnerability' with respect to indigenous peoples would seem to be called for. One approach is to differentiate among the constituent parts of vulnerability: exposure, sensitivity and adaptive capacity (Prno et al., 2011; see also Eriksen, Brown and Kelly, 2005; Parkins and MacKendrick, 2007; Tschakert, 2007; Forbes, 2008; Ford et al., 2008; Keskitalo, 2008; Young et al., 2010). According to the IPCC

(2001), 'exposure' relates to the degree of climate stress upon a particular unit; 'sensitivity' is the degree to which a system will be affected by, or responsive to climate stimuli, either positive or negative; and 'adaptive capacity' refers to the potential or capability of a system to adjust to climate change. In the context of indigenous communities, exposure and sensitivity (commonly expressed as exposure-sensitivity) refers to the 'presence of potentially problematic conditions (exposure) and the occupancy and livelihood characteristics that make individuals and communities susceptible to these exposures (sensitivity)' (Prno et al., 2011: 7364; see also Smit and Wandel, 2006). Adaptive capacity relates to 'both local determinants – e.g. availability of human and financial capital, access to technology, local institutions – and the larger context within which the community operates – e.g. the terms of self-government and federally sponsored programs' (Prno et al., 2011).

In summary, rather than describing indigenous men and women as vulnerable to climate change, it would be more accurate to emphasize their high degree of exposure-sensitivity, while drawing attention to their considerable adaptive capacity. Adaptive capacity contributes to resilience in that it relates to people's ability to modify their behaviour and environment to manage and take advantage of changing climatic conditions (Ford et al., 2006).

The IPCC (2007) defines 'resilience' as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the ability to adapt to stress and change. Resilience is a product of the dynamics of a social-ecological system, whose constituent parts are integrated and interdependent (Robinson and Berkes, 2010). Resilience research focuses on the capacity of social-ecological systems to respond to external disturbances, such as those engendered by climate change (Berkes and Folke, 1998; Berkes, Colding and Folke, 2003; Adger, 2006; Folke, 2006). The concept is commonly represented as multiple stable states within a basin (Holling, 1973; Gunderson and Holling, 2002).

As the above makes clear, resilience bears a close relationship to adaptive capacity. As such, some aspects of resilience can be considered to be components of vulnerability (Gallopín, 2006). Folke (2006: 262) considers a vulnerable social-ecological system as one that 'has lost resilience. Losing resilience implies loss of adaptability'.

3.3. Indigenous knowledge and resilience

Before the 15th Conference of Parties to the UN Framework Convention on Climate Change (UNFCCC), the International Indigenous Peoples Forum on Climate Change (IIPFCC) stated:

> *For generations, we have managed ecosystems nurturing their integrity and complexity in sustainable and culturally diverse ways… Traditional knowledge, innovations and adaptation practices embody local adaptive management to the changing environment, and complement scientific research, observations and monitoring.*
>
> (IIPFCC, 2009)

At global climate change forums, indigenous peoples have long maintained two positions: first, that their homelands are being transformed irreversibly by climate change, and second, that they have unique contributions to make towards climate decision-making due to their extensive experiential knowledge. Indigenous peoples furthermore state that their cultures and traditions are inherently resilient, and that heightened vulnerability is a result of external agency, a combination of political forces and social structures that erode their resource base and their traditional institutions (see Chapter 5).

Resilience is rooted in the traditional knowledge of indigenous peoples. The capacity of the Wemindji Cree of Subarctic Canada to adapt to environmental change is based first and foremost on their in-depth knowledge of the land. 'They use the land and resources, and develop the sensitivity to 'read' critical signs from the environment that something unusual is happening. If they were not connecting with the land, they would not be able to respond effectively to what they were observing' (Berkes, 2009: 153). The inherent dynamism of traditional knowledge systems lies at the heart of this ability to adapt (Berkes, 2012). They are constantly renewed through learning-by-doing, experimenting and knowledge building (Berkes, 2012), processes that allow knowledge holders to adjust and modify their actions in response to environmental change.

The following sub-sections present three examples of resilience rooted in traditional knowledge and practice: resilience from nurturing plant and animal diversity; resilience through diversified land use and mobility; and resilience rooted in social networks and customary systems of governance. However, it is important to bear in mind when considering these examples, that socio-ecological systems have multiple threshold effects influenced by multiple, interacting variables. The crossing of one threshold can produce a cascade effect that leads to the breaching of other thresholds, and this in turn may lead to resilient, but less desirable, alternative states (Kinzig et al., 2006).

3.4. Resilience: stewards of plant and animal diversity

An important source of resilience for indigenous men and women is their ability to nurture and manage domestic biodiversity. Recognizing that crop success is subject to the variability and unpredictability of weather events and the occurrence of pests, indigenous communities have traditionally favoured the cultivation of a diversity of traditional crop varieties over a single high-yield but also high-risk, mono-cropping system (Nazarea, 1998; Hanazaki et al., 2000; Emperaire and Peroni, 2007). In their analysis of three agricultural systems in China, Bolivia and Kenya, Swiderska et al. found that maintenance of diverse traditional crop varieties and access to seeds has been essential for adaptation and survival by poor farmers (see Box 3.1). Even when planted alongside modern crops, traditional crop varieties are still conserved, providing a contingency when conditions are not favourable.

Box 3.1. Interlinkages between traditional knowledge and genetic resources in adaptation to climate variability in China, Bolivia and Kenya

Swiderska et al. carried out participatory research with indigenous communities on the impacts of climate change. They also assessed the role of traditional knowledge (TK) and related agrobiodiversity, landscapes, cultural and spiritual values and customary laws in climate change adaptation. Three case studies undertaken in Karst mountains in south-west China, coastal Kenya, and the Bolivian Andes, provide insight into the role of traditional knowledge and traditional crop varieties in adaptation to climate change.

The findings show that indigenous farmers in these regions are already severely impacted by changes in climate, including drought, with serious consequences for crop production and food security. In each case, the maintenance of diverse traditional crop varieties and access to seeds has been essential for adaptation and survival by poor farmers. Traditional varieties used include drought and wind-resistant maize in south-west China; maize resistant to unpredictable weather and new pests in coastal Kenya; and potato varieties in Bolivia that are more resistant to new pests and lack of rainfall. All three cases found that traditional varieties have the advantage of being cheap and easily accessible, as they come from

farmers' own saved seeds, whereas modern varieties have to be bought, are dependent on market availability, and require costly inputs. While modern agriculture and modern varieties may increase productivity, the case studies show that under conditions of environmental stress and climatic variability, survival depends on more resilient and readily available traditional varieties. In the China and Kenya cases, farmers also identified planting diverse traditional varieties as a means to reduce risk, and emphasized the importance of sharing and exchanging seeds to gain access to diverse varieties. In Bolivia, native plants and biological control are providing a less costly alternative to toxic chemical control, which affects farmer health and leads to resistance in pests. In coastal Kenya, adaptation requires the strengthening of customary governance to restore kaya sacred forests since current governance structures have not been effective.

These studies highlight the close interlinkages and interdependence between TK and genetic resources, and their role in adaptation to climate variability and change. This suggests the need to support initiatives such as local landrace conservation, local seed production, seed fairs, community seed banks, and community-based conservation and adaptation.

Source: *Adapted from the paper 'The Role of Traditional Knowledge and Crop Varieties in Adaptation to Climate Change and Food Security in SW China, Bolivian Andes and coastal Kenya', by Swiderska, K., Reid, H., Song, Y., Li, J., Mutta, D., Ongogu, P., Mohamed, P., Oros, R. and Barriga, S., presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

Traditional farmers have 'domesticated, improved and conserved thousands of crop species and varieties' (Swiderska et al., see Box 3.1). The Andean farmers of Peru maintain a high number of potato varieties (Ishizawa; 2006; Argumedo and Yun Loong Wong, 2010) and the Karen rice farmers of Thailand use seed exchange and social networks to manage landrace variation (Pusadee et al., 2009). In Africa, Shava et al. (2009) discuss the management of diversity in its multiple aspects among farming communities in Zimbabwe, where farmers have fostered diversity in order to guarantee a harvest, but also to fulfil social and cultural needs.

> *These included early maturing traditional maize varieties such as* mukadzi usaende *or* mukadzi dzoka *(literally translating to 'wife don't go' or 'wife come back'), suited for the short rainy seasons or drought spells as well as late maturing traditional maize varieties suited for the longer rainy seasons; and white and red varieties of* zviyo *(finger millet) and* mhunga *(pearl millet). Growing different varieties of the same crop is said to better guarantee a harvest regardless of seasonal variability (short dry season or long wet season) and to ensure variety in taste and quality.*
>
> (Shava, 2009: 9)

Swidden agriculture (also known as slash-and-burn, shifting cultivation or rotational farming) is an integrated system in which hundreds of plants are cropped together in fields and harvested at staggered intervals (Ziegler et al., 2011). A large variety of crops for both food and medicinal uses are planted in such a manner to maximize resource availability in a single field, with annuals being immediately available and perennial plants available in later years. Indigenous men and women in Thailand are able to make use of more than 200 plant species from their fields over the traditional 6 to 10-year fallow period (Ganjanapan and Laungaramsri, 2004). In north-east India, high crop diversity – more than 40 crops in a shifting cultivation landscape, and high diversity of crop varieties – are fundamental to maintaining resilience and ensuring adaptation (Trakansuphakon, 2010).

Similarly, pastoralists maintain genetic diversity within their herds. In an article on 'reindeer luck', Oskal (2000) describes a 'beautiful' reindeer herd from a Sami viewpoint as being 'composed of many reindeer of different shapes and colours giving it a picturesque unity with contrasting black and white'. In India, the *gaushala* (cow shelter), a religiously motivated institution, plays a role in maintaining genetic diversity among cattle (Köhler-Rollefson, 2000).

Differences in resilience that occur within communities, such as between men and women, may be obscured without an adequate understanding of resource access and withdrawal rights. This can be addressed through a 'bundle of rights' approach (Schlager and Ostrom, 1992). In many pastoral societies, the capacity of men and women to respond to climate change impacts relates to their differential rights to access and withdraw resources. While both women and men may possess their own animals, in some societies only the men decide which animals are to be slaughtered. Elsewhere, however, women and even children must be consulted (Flintan, 2008). In a review of research on livestock and livelihoods in sub-Saharan Africa and South Asia, Kristjanson et al. (2010) found that women often control cow's milk for home consumption, but not for income generation. In contrast, McPeak and Doss (2006) found that the right to sell milk among mobile pastoralists in northern Kenya was specifically reserved for women. These differing rights to access and to dispose of resources create gender-specific patterns of vulnerability and resilience.

3.5. Resilience: diversified land use and mobility

> *[Our] knowledge systems have been developed and continue to be developed through our interaction with our lands and territories. Without access to our lands we lose our connections with our ancestors and our knowledge.*
>
> Saul Vincente, Indigenous Peoples, Marginalized Populations and Climate Change Expert Meeting (IPMPCC, 2011)

Resilience due to species or genetic diversity in the field or the herd may be complemented by resilience through diversification at the level of landscape. Traditional land use and management, for example, ensure multiple uses within a single territory. Tauli-Corpuz and Alangui present the results of case studies conducted by indigenous researchers in Nicaragua and Indonesia. The Miskito of Nicaragua maintain three land-use types: cultivated fields, pastures and forest areas. In Indonesian Borneo, a typical Dayak Jalai village territory is composed of multiple land use types (see Box 3.2). In this 'shifting mosaic land-use pattern that Dayak create… are patches of natural forest, managed forests, rotating swidden/fallow, and permanent fields moulded to the ecological conditions of the mountains, wetlands, and river valleys of a particular community's territory' (Alcorn et al., 2003: 306). In many Dayak systems, a typical land area will also include spaces for cash crops including pepper gardens, oil palm, rubber, copra and cocoa alongside fruit orchards, rice fields and vegetable gardens. This multiple land-use system is both a livelihood strategy and a source of resilience. Conversely, undermining local control over these land resources increases the vulnerability of these communities (Box 3.2). Cunningham notes that security of land tenure and the resulting ability to access, manage and extract natural resources is a pre-condition for maintaining the resilience of local communities (see Box 3.3).

Continued access to territories is essential as it preserves the ability to move across different ecosystems in response to localized climate problems. During periods of drought, the Makushi of Guyana '[leave] their savannah dwellings for less hot and smoky places, travelling to their 'high bush farms' in forest areas on hilltops or along rivers, trekking to distant hunting territories, or visiting relatives living in more propitious and moister regions.' Through oral history, it has been documented that the Makushi peoples' primary response to severe drought was to move out from the savannah zone (Rival, 2009: 301).

Box 3.2. Land tenure policies impacting on traditional forest management in Kenya, Nicaragua and Indonesia

Tauli-Corpuz and Alangui have reported the results of three case studies on traditional forest management, as practised by the indigenous peoples of Loita Maasai (Kenya), Miskitu (Nicaragua) and Dayak Jalai (Indonesia). For the indigenous peoples in the three case study areas, the forest is not only a source of sustenance and livelihoods, but also the very basis of their identities, cultures, knowledge systems and social organizations. Community-based forest management strategies in these communities involve the setting aside of conservation, woodcutting and watershed management zones, which have an important role to play in reversing the process of deforestation, thereby sequestering carbon and promoting rural development. A common problem in each of these communities is lack of political control over their land and forests. For the Loita Maasai of Kenya, forest resources are held in trust by the Marok County Council on behalf of the government; for the Miskitu of Nicaragua, use, control and access of natural resources is impacted by government norms and regulations, and external settlers are causing deforestation; and the Dayak Jalai of Indonesia are faced with government-promoted expansion of palm plantations and the continued operations of mining companies.

Source: *Adapted from the paper 'Indigenous Peoples Traditional Forest Management as Means for Climate Change Adaptation and Mitigation,' by Victoria Tauli-Corpuz and W.A. Alangui, presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

Mobility and the option to access resources across an extensive area are, for both hunting and pastoral peoples, essential to the maintenance of their cultures and livelihoods (Ayantunde et al., 2011). They constitute a key component of community resilience. Mobility provides a mechanism for managing areas with low fertility and sparse vegetation.

Galvin (2009: 191) describes pastoralism as a system whereby pastoralists 'access forage and water across space and time through reciprocal rights to common pool resources sometimes belonging to other people.' These rights to use another group's property are the basis for the nonexclusive tenure and land-use systems common to pastoralism (Behnke, 1995; Turner, 1999). According

to Brooks (2004), pastoral livelihoods in the Sahel have historically depended on negotiated, non-exclusive access to water and reciprocal land-use agreements between pastoralists and agriculturalists. Curtailing these social arrangements reduces the flexibility of the overall systems and undermines resilience.

Scholars of pastoralism suggest that exclusionary land title practices are counterproductive to sustainable land use in arid and semi-arid areas. Formal title to private land renders the system more rigid and constricts the normal 'unboundedness, porosity, impermanence, and continual social/political renegotiation' that pastoralism embraces (Turner, 1999: 122).

Box 3.3. Indigenous adaptation measures in the Nicaraguan Caribbean

Cunningham presents the outcomes of 12 case studies in the Nicaraguan Caribbean, representing the ecological areas of the coast, plains, wet tropics and agricultural frontier – places where the *Miskitu*, *Sumu-mayangna*, *Mestizos* and *Garifunas* people live. Increases in the strength of winds and frequency of storms have modified local ecosystems, representing a challenge due to the dependence on water and food supply, the rise in diarrheal diseases and cardiovascular ailments, and the increase in flooding in coastal communities. The loss of forest areas not only results in loss of biodiversity, but also has a significant impact on ways of life of indigenous peoples, including agriculture, community forestry and hunting.

The examination of changes in a variety of traditional practices has identified adaptability measures in the communities of the autonomous regions, These include: delimitation and ownership of territories (such as forming and strengthening the structures of territorial governments, and the creation of alliances); improvement of social control mechanisms and environmental resources; and cultural revitalization (i.e. implementation of measures to strengthen identity, culture and values, such as reinforcement of the role of elders, recovery of traditional foods, and strengthening of traditional medicine).

Source: *Adapted from the paper '*Climate Change: Adaptation Measures on Indigenous Communities in the Caribbean Coast of Nicaragua*,' by Myrna Cunningham, presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

3.6. Resilience: the role of social and cultural institutions

> *It is difficult to separate discussions related to our indigenous belief systems from the environment. So it is doubly difficult to enter these discussions and look at one aspect of our whole life as if it were separate from the rest. To us, everything is connected and often it makes us frustrated to separate things as if these were boxes.*
>
> Minnie Degawan, Co-Chair, Indigenous Peoples, Marginalized Populations and Climate Change Expert Meeting (IPMPCC, 2011)

As described by Adger and Brown (2009), adaptation is a dynamic social process. The ability of societies to adapt is determined, in part, by its ability to act collectively. In managing territory and resources, indigenous peoples use social mechanisms and customary governance structures to ensure equitable access to resources, and thus build the social fabric of resilience in the face of environmental change.

These mechanisms and structures may include customary law and rituals. MRDC and Dekdeken report that in the Philippines, the Pidlisan use a combination of institutions and rules, some formal (e.g. ritual, governance and structure) and some informal (e.g. social prestige), to reduce competition and ensure that rice terraces receive a fair share of the limited water resource. Community unity is cited as a critical factor to ensuring that these rules remain enforced (see Box 3.4).

Puri (2007) describes the importance of social collaboration in responding to uncertainties in food and water supply. He describes how foraging peoples, including the San of the Kalahari Desert in southern Africa, rely on pre-established social networks maintained through reciprocal gift-giving in order to move beyond the area affected by localized climate disturbance. The walkabouts and corroborees of Aboriginal Australians and potlatch ceremonies in the Pacific Northwest ensure in a similar fashion the maintenance of a social safety net (Puri, 2007).

Galvin (2009) describes the distribution of a Masai herd across a social network as a way of:

> *coping with subdivision of land by reaggregating their lands with friends and family. However… some relations in the region are becoming strained as some Masai who live on individual parcels move their herds onto group ranch land during the wet season only to retreat to their fenced pastures during the dry season.*

Box 3.4. Securing resources through the *lampisa* practice of communal water management in times of drought, Philippines

The Pidlisan domain has a mountainous terrain characterized by steep slopes (more than 50%) of high sedimentary mountains with deep ravines. The majority of the residents engage in agriculture with rice farming as the main economic activity. Indigenous farmers in the Cordillera region in Northern Luzon, Philippines, have observed changes in climatic conditions such as prolonged drought and excessive rains. In some instances these have resulted in severe crop damage, a situation that is further aggravated by deforestation. MRDC discuss the *lampisa* system of water distribution, under which people are nominated to take responsibility for the maintenance of the irrigation canals and the rice fields throughout the dry season. The primary task of these *lampisa* is to ensure that all rice fields receive a fair share of water at all times and to conduct regular inspection of the entire irrigation system. This will ensure that water flow is maintained, even in times of drought.

The successful implementation of the *lampisa* system hinges on the power and dedication of community leaders (dap-ay elders and barangay officials) and compliance by the people with the laws governing the system. The *lampisa* system promotes communal use of water resources at a low cost. Although the beneficiaries are obliged to pay for the services of the *lampisa* services, they do so based on a fair value (5% of the total volume of production).

Source: *Adapted from the paper '*Securing food through the *Lampisa* indigenous practice of resource management of the Pidlisan tribe in the Cordillera, Philippines*,' by Montarosa Research and Development Center and Sarah Dekdeken, presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

3.7 Threats to resilience and adaptive capacity

There is general agreement that multiple social and environmental stressors ('exposure-sensitivities') are likely to pose significant challenges for communities (Adger, 2006). Some communities report that they are increasingly unable to address climatic changes in a context where there already exist multiple stressors (Alcorn et al., 2003).

Eroding modes of knowledge transfer and learning, increased alienation of youth from older generations, and the degradation of social networks are all contributing to decreasing resilience and increasing vulnerability of indigenous communities (Ford et al., 2006). If relationships between generations continue to degrade 'the younger generations would have difficulty making sense of their observations because it is the elders that help frame knowledge, and lead the discourse through which observations are translated into new knowledge' (Berkes, 2009: 153).

Today, changing livelihood strategies are also undermining certain aspects of resilience, resulting in emerging vulnerabilities in certain indigenous communities. In some Inuit communities, for instance, the development of a 'waged economy has resulted in rising inequality, individualized behavior, and withdrawal from the traditional subsistence economy' (Ford, Smit and Wandel, 2006: 155) and, thus, the erosion of many of the characteristics that had previously enhanced indigenous resilience.

There is also currently insufficient recognition of gender considerations in climate change discussions, despite evidence that ensuring greater gender equalities in climate change debates would contribute to enhanced resilience and adaptive capacity (Denton, 2002; Terry, 2009a; Terry, 2009b; UNDP, 2009). The 2011 Human Development Report (UNDP, 2011) affirms that the disadvantages of women, who have historically had limited access to resources, restricted rights and little voice in decision-making, make them extremely vulnerable to climate change. Despite this, however, the gender equality dimension has thus far been little considered in the literature on climate change and indigenous knowledge (Nelson and Stathers, 2009).

Chapter 4. Traditional Livelihoods

Key points

- Traditional livelihoods are the mainstay of large segments of the world's population. Pastoralism is practised on an estimated 25% of the global land area and provides 10% of the world's meat production. The majority of the world's fishers are artisanal.
- Subsistence livelihoods are typically small-scale, diversified and rely upon a suite of specialized skills. The mastery of multiple livelihood skills is a source of resilience in times of uncertainty and change.
- Diversification provides a buffer against environmental variability and change. Nomadic herders vary the species and genetic composition of their herds, while small-scale farmers manage risk through their choice of domestic crops and plant varieties, backed up by reserves of wild resources.
- Land-use strategies are another traditional source of resilience. Pastoral peoples move their herds in response to changing environmental conditions and reserve certain pasture areas for years when conditions are extreme. Swidden farmers benefit from multiple resources from fields and forest in multiple stages of fallow and regeneration.
- Policies that provide incentives to abandon traditional livelihoods may undermine the ability of these local knowledge-based systems to respond to environmental change.

4.1. Overview

This chapter explores traditional livelihood strategies and associated responses to climate and other environmental changes. It focuses in particular on three indigenous livelihoods: nomadic or semi-nomadic pastoralism, small-scale agriculture including swidden farming, and small island production systems. Livelihood adaptation opportunities rooted in indigenous knowledge and practice are also discussed.

4.2. Context

Many indigenous peoples rely on resource-based livelihoods that efficiently use and manage natural resources in their localities. These livelihoods, which may include subsistence farming, swidden agriculture, pastoralism, artisanal fishing, hunting and gathering, are small-scale and require specialized skills that are learnt through practical experience. Traditional livelihoods are generally diversified and are often associated with elaborate social and land tenure arrangements that contribute to the management of resources and reinforce societal resilience in the face of change.

In its discussion on the impacts of climate change on rural livelihoods, the IPCC's Fourth Assessment Report (AR4) concluded that the topic required further development, noting that 'a number of case studies of impacts on smallholder livelihood systems in developing countries are beginning to appear'. In an analysis of over 350 case studies of indigenous peoples' adaptation in domains such as agriculture, water management, coastal management, disaster response and health, Galloway McLean (2010) concluded that the most common adaptation responses by indigenous peoples involved adjustments required to adapt livelihoods to changing climatic conditions.

The AR4 urged caution, however, in the analysis of livelihood impacts. Specific impacts (such as those due to climate change) must be examined within the context of whole sets of confounding impacts at regional to local scales (Adger, 2003; Eakin, 2006; Leichenko and O'Brien, 2008). It is difficult to ascribe levels of confidence to these confounding impacts because livelihood systems are typically complex and involve a number of crop and livestock species, between which there are interactions, for example, intercropping practices (Richards, 1986) or the use of draught-animal power for cultivation (Powell et al., 1998), and potential substitutions such as alternative crops (IPCC, 2007).

In their discussion on climate change impacts on remote Pacific island communities in the Solomon Islands, Rasmussen et al. (2009) remark that it is methodologically complex to distinguish adaptive actions and strategies directly related to climate change from general livelihood strategies, which also take into account climatic variability and the risks of extreme weather events. Indeed diversification of livelihoods is a strategy shared by many indigenous peoples to enhance resilience in a context of environmental uncertainty. Kronik and Verner (2010a) consider multi-activity or diversification to be a central adaptive strategy, based on the acquisition of diverse livelihood skills (e.g. fishing, farming, hunting and gathering) and supplemented with new techniques adopted from other peoples, indigenous and non-indigenous. This

capacity for multiple activities is a cultural asset that allows indigenous peoples to adapt and cope with climatic changes.

4.3. Nomadic or semi-nomadic pastoralism

Pastoralism or animal herding is a livelihood practised on an estimated 25% of the global land area, providing 10% of the world's meat production (UNPFII, 2010).

As a livelihood system, pastoralism enables people to cope with low productivity environments that are often characterized by climatic fluctuations and substantial variation in the timing, intensity and nature of precipitation between and within years. Shared characteristics of nomadic or semi-nomadic pastoral systems include the following (Hesse and Cotula, 2006):

- Livestock depend on natural pastures, while rainfall is the most important factor determining the quantity and quality of pastures and the availability of water.
- Herds are composed mainly of indigenous livestock breeds.
- Livestock represent more than just economic assets, they are also social, cultural and spiritual assets, and define social identity.
- Natural resources are managed through common property regimes where access to pastures and water is negotiated and dependent on flexible and reciprocal arrangements.

With respect to African pastoralist communities, the IPCC noted in the AR4 that:

> *Mobility remains the most important pastoralist adaptation to spatial and temporal variations in rainfall, and in drought years many communities make use of fall-back grazing areas unused in 'normal' dry seasons because of distance, land tenure constraints, animal disease problems or conflict. But encroachment on and individuation of communal grazing lands, and the desire to settle to access human services and food aid, have severely limited pastoral mobility.*
>
> (IPCC, 2007: 293)

Subsequent literature on pastoralism in the East African context has stressed the importance of traditional knowledge as a basis for climate change adaptation among pastoral communities, while also noting that external interventions may unintentionally undermine the ability of traditional knowledge-based systems

to respond to environmental change. In the Sahel, climate change adaptation strategies based on indigenous knowledge and practice include the application of indigenous knowledge in weather forecasting, the use of emergency fodder in times of drought, multi-species variability in herd composition to survive climate extremes (e.g. changing from cattle to sheep to goat husbandry depending on the availability and condition of pastures), and a reduction in pressure on stressed grazing areas through a circular movement from dry to wet areas (Nyong, Adesina and Osman Elasha, 2007). Discussing pastoralism in Nyagathom in Ethiopia, Scoones and Adwera (2009) note that the local innovation system is based on a network of people, overseen by elders. They emphasize the importance of clan connections, even extending across state borders, which facilitate reciprocal negotiations over access to pasturelands for grazing. Local specialists guide decision-making by providing forecasts based on the reading of entrails or the interpretations of astrological phenomena. Unfortunately, aid or relief efforts are often in conflict with the traditional indigenous system, undermining pastoralists' abilities to innovate by diverting their energy and attention, while contributing to the development of a 'dependency culture'.

Troeger notes that the 'finely-honed symbiotic relationship between local ecology, domesticated livestock and the Nyangatom people' has been disrupted. Although traditionally resilient, systems that are already stressed by restricted resource access due to local regulations, invasive species that replace traditional food plants, and increasing conflicts for land and resources, may not be able to cope with the additive impacts of climate change such as failing rains and unpredictable river floods (Box 4.1).

Across the Arctic, the pastoral livelihoods of reindeer-herding peoples are also coming under considerable stress from global climate change. Some of the major challenges facing the Sami of northern Sweden can be understood by examining Sami terms and concepts that are intimately tied to the welfare of their herds (Roturier and Roué, 2009). Winter is a particularly difficult season because severe conditions may prevent the herds from gaining access to food and lead to starvation. In this respect, the Sami term for good pasture, *guohtun*, is particularly revealing. Although often erroneously translated as simply *bete* in Swedish or pasture in English, *guohtun* in fact refers not only to the presence of lichen-heath pasture, but also to its accessibility to the reindeer herds. *Guohtun* refers to areas covered by a blanket of snow that herds can dig through to reach their forage (Roturier and Roué, 2009). In contrast, the scourge of every herder is *čuokke*, a pasture locked under a sheet of impenetrable ice (Roué, In prep.). After a warm spell in winter, when snow has melted or rain has fallen, freezing temperatures can quickly cover the landscape with vast sheets of ice that prevent the reindeer from digging down to their food. When these conditions occur, the entire herd may starve if they are not quickly moved to an ice-free zone. Thus, the concepts of *guohtun* and

čuokke pinpoint a critical vulnerability factor for the Sami herding way of life. According to the Swedish Commission on Climate and Vulnerability (2007), global climate change is expected to increase the frequency of oscillating temperature regimes in winter, which in turn will likely increase the frequency of disastrous ice conditions on winter pastures.

Box 4.1. Nyangatom livelihoods under threat

Troeger reports on fieldwork undertaken with Nyangatom, a small agro-pastoralist group in Southwest Ethiopia, who report that their livelihoods are highly impacted by climate change and changing environmental patterns, namely failing *Belg* rains and increasing temperature. People perceive this change as irreversible, naming such environmental indicators as disappearing plants and animals, and discuss having to re-name their seasonal calendar. The social capital necessary for community resilience (captured in rules and regulations, 'ceremonies' of sharing and reciprocal support) is threatened as elements of social cohesion and identity fade away. Examples of this degradation include formerly cattle-rich pastoralists becoming poor, women becoming more dependent on their husbands, leather skirts as attributes of clan affiliation and family status being replaced by cotton skirts, and ceremonies such as *Akunumnum* and *Ekomar* falling out of sync as a result of changes in the timing of seasonal indicators.

Source: *Adapted from the paper 'Everything that is Happening Now is Beyond our Capacity! Nyangatom Livelihoods Under Threat,' by Sabine Troeger, presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

Stating that access to water, grazing land and mobility are central to pastoral livelihoods in arid landscapes of Mongolia, Sternberg (2008) observes that the ecological system is undergoing dramatic changes. A survey of Mongolian pastoralists revealed that the eight most serious problems affecting their lives were all environment-related (Sternberg, 2008). Among these, water-related problems, such as access and supply, precipitation and drought, were considered to be particularly acute. Another study in Mongolia provides similar results. Nomadic pastoralists described more intense droughts and sandstorms as the most serious challenges arising from climate change (Marin, 2010). Opportunities to respond to these threats are constrained, however, because of the loss of grazing lands to competing forms of land use, and also due to externally-imposed changes to livelihood structures, from the introduction of

salaried herders tending state-owned livestock during the Communist era to current, market economy-driven practices (Marin, 2010). Sternberg (2008) notes that 'the predictable results are the deterioration of the rural water infrastructure, intensified grazing patterns, increased land degradation, and an end to cooperative herding decision-making and implementation.'

4.4. Small-scale agriculture

Generations of indigenous farmers have developed diverse, complex and locally adapted agricultural systems that are managed via traditional institutions and techniques. They ensure food security while conserving the diversity of wild and domesticated plants. Climate change may have detrimental impacts on these agricultural systems.

Swiderska et al. highlight the importance of maintaining diverse traditional crop varieties and access to seeds in case studies in China, Bolivia and Kenya (see Box 3.1), while Andean farmers maintain a high number of potato varieties (Argumedo and Yun Loong Wong, 2010), and Karen rice farmers in Thailand employ seed exchange and social networks (Pusadee, 2009). In Zimbabwe, farmers encouraged diversity in crop varieties in order to 'better guarantee a harvest regardless of seasonal variability (short dry season or long wet season) and to ensure variety in taste and quality' (Shava et al., 2009).

Diversifying farming techniques and technologies is also a key characteristic of resilience among indigenous peoples and local communities. Swidden agriculture (see Section 3.4) enables hundreds of plant species and varieties to be sustained, with both food and medicinal plants cropped together in a single field. Plants are harvested at staggered intervals, with annuals available on a regular basis and perennials becoming available in subsequent years.

Recent research confirms the contribution of swidden agriculture not only to the preservation of species diversity, but also to soil and water conservation, and climate-change mitigation (Ziegler et al., 2011). Historically, governments have criticized swidden farmers (who are often members of ethnic minorities) as a driving force for deforestation and degradation of water resources (Fox et al., 2009). Many have been forced to abandon swidden agriculture due to government restrictions, pressures to re-settle and sedentarize, and 'encouragement' to switch to cash crops. These imposed changes have rendered farmers more vulnerable to climate change impacts (Fox et al., 2009), and replaced swidden agriculture with unsustainable land-use practices, such as extensive, long-term cultivation of annual crops, monoculture tree plantations such as oil palm, and livestock grazing (Schmidt-Vogt et al., 2009).

4.5. Small island production systems

Small island systems are commonly characterized as closed systems that require the meticulous management of finite resources, such as water, plants or animals. While this somewhat idealized representation ignores the realities of inter-island trade and the seasonal presence of migratory species, there are nonetheless innumerable examples in small islands of sophisticated traditional resource management regimes that have provided and continue to provide for the social and ecological regulation of resource production, access, harvesting, storage and distribution. This is the case, for example, among small islands in the Pacific, where many remote and geographically isolated communities continue to practise agriculture and fisheries in accordance with traditional resource management and governance systems.

Indeed, there are cases where island ecologies have been considerably modified to enhance their food production capacities, while maintaining their vital ecological equilibrium. Falanruw (1989) describes how the early inhabitants of Yap in the north-western Pacific modified islands into an enthopocentric food production system that transformed the species composition of various habitats, but maintained their ecological function: 'Agroforests buffer rainfall and stabilize and develop soil as do natural forests, taro patches and swamps function as silt traps, and mangroves provide a source of wood and nearshore areas for fishing and shellfish gathering, while continuing to perform their buffering, filtering and fish nursery functions.'

In their study of the Torres Islands of northern Vanuatu in the South Pacific, Damon and Mondragon draw attention to local agricultural tenure and cropping patterns, which result in a patchwork of crops with mixed ownership (Box 4.2).

> *[Because] it implies a distribution of environmental risk, this scattered pattern of food producing sites is critical to enhancing human and ecological capacities to cope with climatic fluctuations such as drought, excessive rainfall or future sea level rise. In this respect, it can be clearly stated that local forms of social organization, i.e. the Torres kinship system and its associated forms of inheritance, settlement patterns and gardening times, in conjunction with knowledge of varieties and availability of major fertile soil types, constitute a key reference for outsiders wishing to understand Torres islanders' capacity to adapt to climate change in the near future.*

Fishing is another essential component of small island production systems. Marine fish, turtles and invertebrates not only serve as the primary source of protein, but also function as key elements in the social and cultural life of the community and provide opportunities for economic development. The

Box 4.2. Adaptation of small island societies in Papua New Guinea and the Torres Islands

Mid and long-term environmental fluctuations have long been a part of Melanesian engagements with the physical world, and have consequently given rise to coping strategies that are inherent to traditional knowledge practices. Damon and Mondragon report on two case studies of indigenous adaptability to climate change in Island Melanesia.

In the first case, the islands of Muyuw and the Kula Ring of Papua New Guinea constitute an extremely dynamic climatological environment, one in which patterns of drought and rainfall have had a profound impact on the human stewardship (and modification) of the islands' vegetation and soils. Local populations report significant concerns with sea level rise and observed alterations in complex understandings of weather patterns. Harvest activities vary because people expect intra-annual patterns to be unpredictably upset by interannual patterns, the droughts of ENSO events.

The Torres Islands are situated in a very highly active seismic region that provokes constant, violent shifts in shoreline ecologies and hydrodynamics. Distributing environmental risk is a central element in traditional small island vulnerability mitigation strategies, such as the scattering of food production sites. The authors argue that overall changes to the local shoreline, especially in relation to soil quality, vegetation growth and hydrodynamics, as provoked by extreme seismic uplift and downlift, offer a unique and informative example of the long-term adaptability that is present in both the human population and the observed coastal milieu of these islands, and is applicable to climate change adaptation.

Source: *Adapted from the paper 'Seasonal environmental practices and climate fluctuations in Melanesia. An assessment of small island societies in Papua New Guinea and Vanuatu,' by F. Damon and C. Mondragon, presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

different roles of men and women in island fisheries show that climate change can have differing impacts. In an overview of climate change and food security in the Pacific, FAO notes that

> *Pacific women are mostly responsible for gleaning inshore waters and reefs for fish, shellfish and other marine products… [P]rojections for more intense tropical cyclones and rise in sea surface temperature will negatively impact inshore fisheries, affect women's source of income and, more importantly, hamper household food supply, especially in the rural areas.*
>
> (FAO, 2008: 16)

Small-scale tropical fisheries differ from industrial fisheries in many ways, among which, importantly, that they are generally not open access, but subject to customary ownership with associated rights that allow for the regulation of entry and resource use by outsiders (Ruddle and Hickey, 2008). Customary marine tenure provides the legal and cultural foundation for many traditional marine management practices, particularly in the Pacific where such systems are well developed (Cinner, 2005). Due to their long history of coastal resource use, tropical nearshore fishers possess a profound local knowledge of their tenured waters, which is put to good use to enhance fishing and manage resources (Johannes, 1981; Ruddle and Hickey, 2008).

In areas with customary marine tenure, traditional fisheries management is based on classical fishing controls such as limited access, closed seasons, no-catch zones and species-specific prohibitions (Johannes, 1978, 1981; Ruddle and Hickey, 2008). Indeed, as pointed out by Johannes (1978), all present-day fisheries management techniques were already in use in the Pacific islands long ago, prior to European colonization. Examples include the no-fishing or *tabu* areas of Fiji, Vanuatu and Kiribati; the *ra'ui* in Cook Islands; the *masalai* in Papua New Guinea; and the *bul* in Palau. In Palau, the *bul* can be put in place to close an area of reef to harvesting on a short-term basis, for example, during periods of fish spawning (Vierros et al., 2010), while in Vanuatu networks of spatial-temporal refugia are created as part of a range of customary practices that include, depending on the cultural group, the ordination or death of a traditional leader, death of a clan member, grade-taking rituals, and as part of agricultural and ritualized exchange cycles (Hickey, 2006, 2007). These practices serve as fisheries management measures providing for sustainable use and increased resilience of the target species, as well as the ecosystems they inhabit. Moreover, they allow fishing communities to constitute important living food reserves that increase their resilience in times of environmental uncertainty. Similarly, traditional aquaculture also increases food supplies in proximity to communities. For example, in Vanuatu, fishers create 'giant clam gardens' by gathering giant clams into discrete areas on reef flats for use in times of inclement weather when fishing further afield

is not possible. This may have also served to increase reproductive success by maintaining a breeding population dependent on external fertilization in close proximity (Hickey, 2006).

While such practices have been amply documented in the Pacific Islands, traditional fisheries management practices exist worldwide. For example, in the Maluku Islands of Indonesia, entry, harvest or hunting in community-controlled areas are regulated through the practice of *sasi*, a long-standing social institution for restricting access to certain resources. Tribes of the Pacific Northwest of North America possess a variety of access-control mechanisms, such as rules for appropriate harvesting behaviour, and rituals that regulate resource use, for example, the opening dates of the salmon-fishing season (Williams and Hunn, 1982).

Many traditional resource users commonly monitor the status of their resources. This monitoring capacity is often much more fine-grained than scientific efforts, due to the proximity and regular contact of resource users with, not only target species, but the ecosystem as a whole. For example, Icelandic fishers communicate extensively among each other about fish distributions and abundance, and coastal communities monitor clam populations in Maine, USA, to help determine areas requiring enhancement

Box 4.4. Resilience of artisanal fishing in Cape Verde

Traditional fishing communities are vulnerable to climate change due to increasing uncertainty of resource availability and access. Ilic (2011) reports on the vulnerability of a fishing community in Tarrafal Island to inter-generational loss of knowledge, as well as the adaptive activities or coping strategies implemented by the community, such as changing the scale of fishing activities, altering target species depending on season and availability, employing a variety of fishing techniques, income diversification and out-migration.

Source: *Adapted from the paper 'I am counting moon, I am counting fish: traditional environmental knowledge and social vulnerability of artisan fishing community of Tarrafal, Sao Nicolau, Cape Verde,' by J. Ilic, presented at the International Expert Meeting on Indigenous Peoples, Marginalized Populations and Climate Change: Vulnerability, Adaptation and Traditional Knowledge, 19–21 July 2011, Mexico City, Mexico (IPMPCC, 2011).*

(Berkes, Colding and Folke, 2000). Community-based monitoring not only enhances management decision-making, but also provides a means whereby the effects of climate change can be observed locally. Thus, monitoring by traditional small-scale fishers contributes to adaptive management, as well as climate change adaptation.

In artisanal fisher communities in Tarrafal, Cape Verde, Ilic notes that community livelihoods are characterized by a high degree of flexibility and adaptability. Communities traditionally fish on a small scale and switch target species according to season and abundance, and occasionally practise occupational pluralism (e.g. obtaining income from other activities, and food from alternative sources). However, the increasing uncertainty of resource availability and access is leading to the loss of fishing knowledge from one generation to the next, with a resultant increase in vulnerability (see Box 4.4).

Chapter 5. Adaptation Policy and Planning

Key points

- Indigenous peoples have long and multi-generational histories of interaction with their environments that include coping with environmental uncertainty, variability and change. They have demonstrated their resourcefulness and response capacity in the face of global climate change.

- Resilience in the face of change is rooted in indigenous knowledge and know-how, diversified resources and livelihoods, social institutions and networks, and cultural values and attitudes.

- An understanding of how policies may affect indigenous resilience is key to creating a policy environment that supports community efforts to adapt through opening up options and encouraging innovation in the face of uncertainty.

- Some governmental policies have negative effects on adaptive capacity. By removing options and reducing choices, they constrain, restrict and undermine community efforts to adapt.

- Policies supporting resilience and adaptability include those that maintain the integrity of and access to traditional territories, reinforce local practices sustaining crop or herd diversity, and enhance transmission of indigenous knowledge, values, attitudes and worldviews.

- Decision-making processes for climate action are most effective if they are accountable and responsive to the populations that are affected, and provide support for effective participation and representation in climate governance.

- A crucial challenge is to ensure that indigenous peoples are involved as key partners in the development of climate change research and adaptation plans.

- Collaboration between indigenous knowledge holders and mainstream scientific research is generating new co-produced knowledge relevant for effective adaptation action on the ground.

- An increasing number of indigenous communities (particularly in developed countries) are moving towards the creation of more formal adaption plans. However, adaptation planning and research is not evenly distributed across regions.

5.1. Overview

This chapter examines the emerging role of adaptation planning in indigenous peoples' communities. It considers, in particular, the impacts of various actions and policy options on indigenous knowledge, coping strategies, traditional technologies and social networks that together render communities resilient in the face of change. The choice of policy options is significant as they may either reinforce community resilience, enabling them to mobilize fully their endogenous adaptive capacities, or hamper or undermine their response capacity.

5.2. Context

Indigenous societies exist within larger nation states. For this reason, climate change impacts or adaptation processes must also consider broader national and international policy frameworks that encapsulate and influence action at the community level. The IPCC has defined planned adaptation as 'adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state' (IPCC, 2001: Annex B).

From this perspective, policy decisions that affect a community's ability to cope with changing environmental conditions may be worthy of special attention. It would seem critical to differentiate between policy decisions that support and empower indigenous peoples by reinforcing their resilience, from those that may undermine their adaptive capacities. In other words, adaptation planning at local, national and international levels may be fruitfully directed at creating a policy environment that facilitates the fullest expression of indigenous adaptive capacity in the face of climate change (Ford et al., 2007; Ford, Pearce, Duerden et al., 2010; Nyong, Adesina and Osman Elasha, 2007).

For many communities, however, there is a marked disconnect between public policies and traditional knowledge-based adaptation. At present, deliberations on policy responses to climate change are typically restricted to the national level. But national strategies developed and implemented by governmental agencies are often not conducive to indigenous efforts to adapt to climate change, which are rooted in local knowledge, sustainable livelihoods and community-based innovation. Government programmes may take initiative out of the hands of the people engaged at the community level. Policies that encourage collaborative efforts where indigenous communities are directly involved in defining priority concerns and information needs are more likely to succeed.

5.3. Policy support for resilience

Little work has been done to identify the different policy environments that might galvanize or alternatively undermine endogenous capacities for climate change adaptation (Adger et al., 2011). A review of the literature nevertheless identifies some key policy domains that have an impact on community-level adaptive capacity, including: sustaining biological and cultural diversity; maintaining territorial integrity and mobility; and enhancing the transmission of indigenous knowledge and practices.

Crop and herd diversity, landscape diversity, linguistic diversity and diversity of livelihoods are all components of cultural and biological diversity. These elements are socially and culturally-created and maintained, and contribute significantly to community resilience in the face of environmental variation and change.[2] In many cases, however, external pressures including development impacts, external agricultural policies, forced migration and market economics, are leading to loss of traditional knowledge, fragmentation of communities and, consequently, loss of valuable adaptive capacity.

Access to alternative lands and resources is a strategy relied upon by numerous societies when facing difficult environmental conditions. When drought is severe or ice crusts lock winter pastures under ice, herds must be moved rapidly to new locations or risk perishing (Reinert, Mathiesen and Reinert, 2010; Roué, In prep.). In disastrous years when crops fail due to drought, floods or pests, small-scale farmers in many parts of the world fall back upon wild forest foods in order to scrape through these difficult times. When the hunt fails, hunters must be knowledgeable and resourceful in shifting to other locations and other game to bring food back to the home.

2 The importance of the contribution of cultural and biological diversity to maintaining resilience and adaptive capacity is discussed in greater depth in Chapters 3 and 4.

Indigenous territories contribute to community resilience by offering alternative spaces and resources that serve when environmental surprises threaten disaster. But today many indigenous peoples around the world find their traditional territories increasingly hemmed in. Territorial integrity is disrupted by forestry, mining or hydroelectric projects, national parks, tourism infrastructure and urban expansion (Marin, 2010; Roué, In prep.). This encroachment on indigenous lands diminishes community resilience and adaptive capacity in the face of climate change.

In many countries, formal education continues to contribute to the erosion of indigenous languages and knowledge. Compulsory schooling not only interrupts traditional channels of cultural transmission by removing children daily from family and community settings, but also inculcates children with external values that may clash with and even undermine traditional teachings. This loss of indigenous language and knowledge weakens the social capital of younger generations, which may result in diminished survival skills in the face of an increasingly uncertain Arctic environment (Ford et al., 2010); reduced knowledge of pastures and watering places that may place herds in sub-Saharan Africa at risk in times of drought (Ole Saibatu, see IPMPCC, 2011); or limited familiarity with cultivars that may reduce adaptation options for subsistence farmers facing increased climate variability in the Andes, Africa and Asia (see Box 3.1).

Policies that promote 'bothways' education, nurturing indigenous language and knowledge alongside mainstream instruction, provide young generations with options and sources of innovation that may strengthen community resilience in the face of change (Ford, Pearce, Duerden et al., 2010).

5.4. Knowledge co-production: indigenous and scientific collaboration

The challenges brought on by global climate change are beyond the lived experience of all knowledge holders, whether scientific or indigenous (Huntington et al., 2005; Nuttall et al., 2005). Effective adaptation planning requires access to the best available knowledge, whatever its source. In the face of climate change risks and impacts that remain uncertain and unpredictable, there is a growing need for policies and action that foster the co-production of new knowledge sets, based upon collaborative efforts involving community-based knowledge holders and natural and social scientists. Co-management regimes that bring communities and the State together to jointly manage natural resources, have provided an important arena for the development of knowledge co-production (Freeman and Carbyn, 1988; Inglis, 1993; Kofinas, 2002).

Armitage et al. define knowledge co-production as 'the collaborative process of bringing a plurality of knowledge sources and types together to address a defined problem and build an integrated or systems-oriented understanding of that problem' (2011: 996). These cross-scale and cross-cultural methodologies provide an important framework for adaptation action on the ground (Alexander et al., 2011; Berkes, 2012). For example, in the United States, the Swinomish climate change initiative combined Coast Salish cultural knowledge with US government scientific expertise. The results included identification of the extent of impacts and areas of concern for water quality (SITC, 2010). In the Arctic, remote sensing (through use of satellite research systems such as Landsat and AMSR-E) and other scientific methods (e.g. meteorology, modelling) are being combined with the indigenous knowledge of Sami and Nenets reindeer herders to co-produce datasets to improve decision-making, herd management and adaptation strategies (Maynard et al., 2005). In Africa, rainmakers in the Nganyi community of western Kenya (Guthiga and Newsham, 2011), and farmers in Nessa Village in southern Malawi (Kalanda-Joshua et al., 2011), have collaborated with meteorological scientists to produce integrated forecasts that are being disseminated by both indigenous and conventional methods to enhance community resilience.

In their analysis of collaborative management and community-based monitoring in the Arctic, Berkes et al. (2007) underline the capacity of indigenous observation to make sense of complex changes in the environment through qualitative assessment of numerous variables (as opposed to science's quantitative assessment of a few). This holistic approach to complexity, which is akin to 'fuzzy logic', provides for monitoring that is of a different and complementary nature to scientific observation (Peloquin and Berkes, 2009). Looking at indigenous practices traditionally used by Maori in New Zealand for harvesting shearwater (*Puffinus griseus*) and by Cree First Nations in Canada for fishing, Moller et al. (2004) argue for the added value of associating indigenous and scientific knowledge holders in natural resource management. In a study of impacts from salmon aquaculture in British Columbia, Canada, Heaslip (2008) comes to similar conclusions with respect to marine environmental monitoring. These results, which point to the benefits of associating indigenous and scientific observing systems, may also provide insights for climate change monitoring efforts.

5.5. Information technologies and indigenous knowledge

One emerging pathway for climate change adaptation places cutting edge technologies, such as information and communication technologies (ICTs), at the service of indigenous knowledge holders. These tools allow them

to determine which data to collect, which questions to ask, and can guide interpretation of results. In the Russian Siberia case, satellite imagery is being trialled to detect and guide reindeer herd movements in order to avoid ice-covered pastures in winter, wild fires in summer, and rapidly expanding oil and gas infrastructure that threaten to bar traditional migration routes (Maynard et al., 2005). The Igliniit project in Arctic Canada, co-designed by Inuit hunters and geomatics engineers, allows hunters to observe and monitor environmental change during their displacements on the land using a device that combines a Global Positioning System (GPS), a personal data assistant (PDA) and a mobile weather-monitoring device (Gearheard et al., 2011). Expert San trackers have successfully used Cybertracker, a similar GPS/computer device, to monitor wild game in National Parks in southern Africa (Liebenberg et al., 1999).

Training in using modern technologies is a priority for many indigenous youth (e.g. the use of GPS collars by reindeer herders to track animal movements). One model that facilitates this type of capacity building is the University of the Arctic, which networks about 100 universities and colleges throughout the region. These are linked through distance learning, enabling indigenous students from around the circumpolar world to learn GIS, Landsat classification, and other scientific techniques.

5.6. Challenges for adaptation planning

> *The inability to manage stresses does not fall from the sky. It is produced by on-the-ground social inequality; unequal access to resources; poverty; poor infrastructure; lack of representation; and inadequate systems of social security, early warning, and planning. These factors translate climate vagaries into suffering and loss.*
>
> (Ribot 2010: 49)

Our knowledge of the social dimensions of vulnerability, and the policies and programs required to reduce it, are as yet inadequate (Ribot, 2010). A deeper understanding of the diverse causal structures of vulnerability is needed to determine appropriate solutions and policy responses. Attention has been directed at the assessment of climate change impacts. This risk-hazard approach identifies places and peoples who are at risk (high exposure), but reveals little about why specific places or peoples are vulnerable and may lack response capacity. Following Sen (1981), an alternative approach views 'vulnerability as a lack of entitlements' and focuses on society's responsibility to provide resources (entitlements) that enable people to increase their resilience in the face of climate change (Adger and Kelly, 1999; Ribot, 2010).

As argued by Cameron (2012), the persistence of colonial relations and its effects on vulnerability and adaptation must also be considered part of the climate change equation. Ill-conceived climate mitigation policies to reduce greenhouse gas emissions may disrupt indigenous land management practices (ICHRP, 2008) and drive traditional subsistence economies to increasing dependency (White, 1976). Rapid industrial expansion of oil and gas, mineral and fisheries development may undermine territorial governance and indigenous self-determination (Cameron, 2012).

Additional challenges relate to the distance between sites of vulnerability and decision. While vulnerability is experienced at the local level, it is at the level of governmental institutions that policies that may reduce climate change vulnerability are developed and implemented (Ribot, 2010; Agrawal, 2010). Decision-making processes for climate action must therefore be accountable and responsive to the populations that are most affected. Mobilizing and supporting marginalized groups to participate effectively in representative governance processes is essential (Ribot, 2004).

Positive governance outcomes require the full and effective participation of indigenous peoples and local communities in monitoring impacts of climate change, and in formulating and implementing mitigation and adaptive responses. Indigenous peoples have called for the full recognition and implementation of their individual and collective rights, as affirmed in the 2007 United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), in all decision-making processes and activities, including those related to climate change (see Anchorage Declaration, 2009; International Indigenous Peoples Forum on Climate Change, 2009; Oaxaca Action Plan, 2011). These include, most notably, the recognition and respect of self-determination (UNDRIP Articles 3 and 4), the right to lands, territories and resources (Articles 8, 25, 26 and 28), the right to free, prior and informed consent (Articles 10, 11, 19, 29, 30 and 32) and the right to participation in decision-making (Article 18).

To ensure that the views of indigenous peoples are incorporated into climate change adaptation plans, programme design and implementation should integrate indigenous knowledge and support customary rights to lands and natural resources. This means that policy environments should be developed and structured to support a proactive role for indigenous peoples at the national level, affirming their role as national providers of 'climate knowledge' and making the case for funding their essential climate response activities. Adaptation measures that make use of indigenous knowledge are critically important for the effective implementation of adaptive activities in indigenous and marginalized communities. Local capacity building (e.g. building local knowledge and strengthening local organizations) is another essential

component. A holistic approach that integrates the social and natural sciences and indigenous peoples' traditional knowledge and worldviews can help to co-produce solutions to the future challenges of climate change.

Most indigenous peoples and local communities are in the early stages of adaptation planning. The great majority of initiatives are limited to addressing short-term or interannual climate pressures, and are intertwined with related sustainable development activities, such as disaster management planning and income diversification strategies (Galloway McLean, 2010). Only a small number of adaptation measures in indigenous and marginalized communities explicitly consider scenarios that look decades into the future.

Nevertheless, a small but increasing number of indigenous communities, particularly in developed countries, have begun to move toward the creation of more formal adaptive plans, and these are now in the early days of implementation. For example, the Swinomish Climate Change Adaptation Initiative in the United States is a sophisticated, long-term and community-specific project. Recommendations in this adaptation plan range from technically complex and costly improvements to community infrastructure and services (e.g. building/raising dikes, raising road levels, and relocating or abandoning routes in response to the expected impact of inundation of low-lying roads and bridge approaches), to less expansive planning activities such as increased reliance on traditional community management techniques (e.g. strengthening traditional roles for food safety and aquaculture operations in response to physical health risks from toxic seafood contamination). Key principles for implementation of adaptation actions identified in the project include flexibility in approaches, public education and outreach, relevancy, addressing political realities, phasing in incremental approaches, and supporting cooperative efforts through regional partnerships (SITC, 2010).

Examples of formalized planning in other regions include the National Climate Change Adaptation Research Plan targeted to the adaptation planning needs of Australia's indigenous peoples (Langton et al., 2012); the Hui Report in New Zealand, which resulted from formal consultations between Maori and the Ministry of Environment (New Zealand Government, 2007); and numerous projects funded under the Climate Change Adaptation Program in Canada (Indian and Northern Affairs Canada, 2010).

Nelson and Stathers (2009) note that gender equality analysis is often absent from adaptation plans. Rather than differentiate interests or possible impacts with respect to climate change according to gender, reference is only made to 'vulnerable communities'. A laudable exception is the Islamic Republic of Mauritania's National Adaptation Programme of Action (NAPA) which acknowledges the different impacts of climate change on men and women,

highlighting that 'with the increasing frequency of drought experienced in Mauritania, it is women who have to walk longer distances to collect water and firewood or develop new income-generating activities, such as weaving, tie-dying, etc.' The NAPA goes on to recommend that 'Women are often the chief guardians of vital local and traditional knowledge. Thus, they need to be recognized as key stakeholders in the consultation and decision-making processes, even though they have not been represented in great numbers' (Ministry of Rural Development and of Environment, 2004).

Finally, policy-research agendas need to take particular note of regions where climate information is limited. While a few robust impact assessments that incorporate indigenous knowledge have been undertaken (e.g. ACIA, 2005), and while adaptation research is well underway in some regions (notably in the Arctic as reported by Ford et al., 2010), in the vast majority of regions occupied by indigenous peoples and local communities there is a paucity of information and research.

Chapter 6. The Americas: Regional Report

Key points

- Climate change is already severely impacting indigenous livelihoods in the Americas.
- Indigenous knowledge relating to climate change, whether it concerns agricultural techniques, biodiversity, indicators of change or weather prediction and response, provides the basis for many successful and cost-effective adaptation measures.
- Indigenous knowledge transmission is threatened by social, cultural and environmental drivers, including climate change, resulting in erosion of the knowledge base and its potential to respond to climate change.

6.1. Overview

This chapter provides an overview of recent research on climate change impacts in North America and Central and South America. It explores adaptation measures based on indigenous knowledge relating to climate change (agricultural techniques, reliance on biodiversity, indicators of change, weather prediction and response), and discusses threats to resilience in the region.

6.2. Context

The Americas are characterized by a high degree of cultural diversity. Over 1000 indigenous languages are reported to be spoken within the region (Nettle, 1999; Gorter et al., n.d), which by some estimates is home to an indigenous population of approximately 31 million (Maybury-Lewis, 2006). However, more recent research indicates that in Latin America alone has an indigenous

population of more than 47 million (UNICEF/FUNPROEIB Andes, 2009). This variation is due in part to the different ways that indigeneity is defined, as well as the challenges of enumerating 'indigenous peoples' given the often negative social, cultural and economic ramifications associated with assuming such an identity (Montenegro and Stephens, 2006).

The spatial distribution of indigenous groups coincides with a large proportion of the biodiversity of the Americas (Sobrevila, 2008). A significant number of protected areas in the Americas are found within or overlap with indigenous lands, territories and resources. Indeed, almost 80% of protected areas in Latin America (Daniels, 2003) are indigenous-owned or inhabited. Recent studies show that areas governed by indigenous peoples are least prone to deforestation (Kronik and Verner, 2010a; Ricketts et al., 2010). In the United States, Native American tribes have a controlling interest in more than 375,000 km^2 of lands (Redford and Grippo, 2008). In Canada, although the exact acreage of land under First Nations control is hard to quantify because of the structure of treaties and land claims, First Nations remain the principal occupants of large tracts of undeveloped land throughout the country.

Indigenous peoples depend on a wide variety of ecosystems and environments within the region. A large majority live in environments that are particularly susceptible to climate change: the highlands (Andes), warm tropical lowlands and rainforest (Mesoamerica and the Amazon), desert regions (Northern Mexico and south-west United States), temperate and boreal forests (Canada), and cold and polar regions (Arctic). The majority of indigenous peoples in the Americas – especially in Latin America – continue to depend on natural resources for their livelihoods (Perreault, 2011).

The livelihoods of many indigenous peoples in the region, however, are already severely compromised (Kronik and Verner, 2010a). A 2006 report from the World Bank states that indigenous peoples in Latin America are among the most disadvantaged and marginalized groups (Lopez and Maloney, 2006). In the United States, research indicates that more than one-quarter of the American Indian and Alaska Native population lives in poverty, a rate that is more than double that of the general population (Sarche and Spicer, 2008), while approximately 13.3% lack access to safe drinking water (US Department of Health and Human Services, 2006).

For indigenous peoples in the Americas, human development indicators such as health and education are consistently significantly lower than those of the rest of the population (Hall and Patrino, 2006; Salee, 2006; Sarche and Spicer, 2008; Stephens et al., 2006). In Canada, First Nations peoples have shorter life expectancies, higher unemployment, lower educational attainment, and lower average annual incomes compared to other Canadians (Cook,

Beavon and McHardy, 2004; Salee 2006). Limited access to infrastructure, services and political representation places indigenous peoples among the most vulnerable groups to the negative effects of climate change (Kronik and Verner, 2010b; Salee, 2006).

Despite their heightened exposure and restricted opportunities to respond, indigenous peoples are well placed to contribute towards the crafting of effective and resilient responses to climate change. Based on their in-depth knowledge of the ecological systems in their own localities (Gadgil, Berkes and Folks, 1993; Schmidt and Peterson, 2009), indigenous peoples in the Americas are exploring multiple adaptation strategies, including agricultural techniques, interpretation of environmental indicators of change, the ability to predict and prepare for climatic variation, and maintenance of biodiverse areas (Berkes, 2012).

6.3. Impacts of climate change

Indigenous peoples in the region are already feeling the impacts of climate change and variability. Changes in precipitation patters have been observed and extreme events are becoming more common (De la Torre, Fajnzylber and Nash, 2009). These changes are affecting indigenous peoples' livelihoods, health and general well-being, and additional impacts are anticipated, such as conflict, migration, greater income inequality, and increasing dependence on food aid and similar forms of assistance (Jones and Thornton, 2003; Ford, Smit and Wandel, 2006; McLeman and Smit, 2006; Reuveny, 2007; Ford, Berrang-Ford, King et al., 2010; Kronik and Verner, 2010a).

Rising atmospheric temperatures are causing the melting of tropical glaciers, which in turn affects the volume of water available for agriculture and domestic use on indigenous lands and territories (Bradley et al., 2006; De la Torre, Fajnzylber and Nash, 2009; Verner, 2010a). Impacts on available freshwater resources are threatening the security and well-being of indigenous peoples (Barnett, Adam and Lettenmaier, 2005). Warmer temperatures are also having a palpable impact on crop yields and food security in general, and on traditionally grown crop varieties in particular (Jarvis et al., 2011; Kronik and Verner, 2010). Rising temperatures in the Andean region have caused increased incidence of *Rhigopsidius tucumanus* infestation in potato harvests that Andean indigenous peoples rely on as a staple food crop (Ulloa et al., 2008). For the Lac du Flambeau Indian Tribe in the United States, continued changes in water quality and hydrological patterns due to climate change could produce conditions that displace the production of wild rice, a food source central to Ojibwe traditions and spirituality (Dussias, 2009).

Climate change is having an impact on flora and fauna, which indigenous peoples have traditionally relied on for subsistence. In the Amazon, for example, insufficient flooding has directly affected fish and turtle reproduction – two species that indigenous peoples in the Amazon depend upon as a food source (Kronik and Verner, 2010b). In the Pacific north-western United States, the demise of wild salmon due to climate change is a major concern for the American Tribes that rely upon it for their religious, cultural and economic livelihood (Krakoff, 2008). Wild edible plant and fruit species have also been affected, causing a shortage of food in the Amazonian and sub-Andean region (Kronik and Verner, 2010b).

Rising sea-surface temperatures are also having an impact, directly affecting the migratory patterns of fish stocks and other biodiversity (Macchi et al., 2008). In Panama, the Kuna have noticed that the rising temperatures are affecting coral life (fish and lobster) that they depend upon for their livelihoods (Murray and Ouellet-Decoste, 2008). However, environmental changes may have complex patterns. On the southern coast of Brazil, offshore fishers have observed increasing sea-surface temperatures. However, small-scale fishers, who operate closer to the coast, have observed an opposite trend: lower sea-surface temperatures (Gasalla and Diegues, 2011). Such an observation is consistent with the appearance of stronger winds from the land, creating local upwelling along the coast, with cooler water temperatures, and is supported by satellite images showing a narrow band of cooler water along the coast for the period 1985–2006 (Gasalla and Diegues, 2011: Plate 7).

Atmospheric temperatures are also affecting the geographical range of disease vectors, causing new health problems, for example, new strains of malaria in the Amazon and increased frequency of pneumonia in the Andean region (Montenegro and Stephens, 2006; Greer et al., 2008; Feo et al., 2009). In the Americas, increased incidence of droughts and floods has caused a surge in epidemics (Haines et al., 2006) and pest infestations (Altieri and Nicholls, 2008), and has displaced hundreds of indigenous peoples (Hardoy and Pandiella, 2009). Floods and droughts are also some of the leading drivers in rural-to-urban migration (Bates, 2002; Balderrama Mariscal et al., 2011).

Rising sea levels are also causing an increase in floods and storm surges, and are directly affecting coastal settlements. For instance, in Nicaragua the Miskito are being forced to relocate from their territories as a result of floods (Ulloa et al., 2008). There is also a reported increase in saltwater intrusion into aquifers used for drinking water and agriculture, which is adversely affecting indigenous peoples (Tsosie, 2007).

The notable increases in the frequency and severity of extreme events is causing human deaths and damage to livelihoods, production systems and food security

(Ulloa et al., 2008). Higher temperatures combined with decreased available soil moisture are increasing deforestation in the region (Malhi et al., 2008) and consequently adversely affecting the livelihood of indigenous peoples.

6.4. Current sensitivity/vulnerability

Climate change is increasing existing vulnerabilities of indigenous peoples by threatening the assets that indigenous peoples depend on for their livelihoods and wellbeing: land, socio-cultural practices, governance structures and natural resources. This heightened exposure is compounded by the fact that many indigenous peoples in the Americas directly depend on natural resources often found in already environmentally fragile areas (high altitude zones, deserts, tropics, etc.). Experience also shows that vulnerability to climate change increases when combined with poverty, ill-maintained infrastructure and inadequate political structures (Kronik and Verner, 2010a).

Indigenous peoples' exposure to climate change is also tied to several important external factors including economic pressures (i.e. mining, development, commercial agriculture, market economics) and legal and political uncertainties (i.e. lack of legal recognition of property rights, access to the political system, pressure from law enforcement, etc.).

Indigenous socio-cultural institutions and governance structures are also exposed to the impacts of climate change. Indigenous peoples rely on complex socio-cultural governing systems and on their traditional knowledge to predict and prepare for seasonal and climate changes (Verner, 2010). But climate change is making it more difficult for indigenous peoples to accurately predict or adequately prepare for unforeseen changes, resulting in loss of social and political capital. For instance, traditional elders, considered local experts by their respective groups, may lose credibility when climatic conditions become increasingly difficult to predict. This may undermine traditional governance and political structures, sacred rituals, and the ability to maintain social order and cohesion (Adger, 2003; Kronik and Verner, 2010a).

6.5. Adaptation and resilience

Recent literature suggests that the ability to withstand shocks and stresses to livelihoods is especially important in adapting to climate change and variability (Hanazaki et al., In press; Thomas et al., 2007). In the Americas, indigenous peoples are accustomed to environmental change and variation. Among

their main assets for adaption are their ability to diversify (i.e. multiactivity or diversification), their rich repository of traditional knowledge (Altieri and Nicholls, 2008; Kronik and Verner, 2010b), and their complex and robust social networks (Berke, Colding and Folke, 2003; Ford, Smit and Wandel, 2006).

Indigenous livelihoods in the Americas favour diversity over specialization. Both men and women assume multiple roles: farming, fishing, foraging, navigating, and so on (Kronik and Verner, 2010b). For instance, the Comcaac people of Northern Mexico have traditionally been semi-nomadic hunters, gatherers and fishers relying on both the desert and the coast for their subsistence. Their ability to procure food from the sea (turtles, fish, shellfish, etc.) and from the desert (lizards, small mammals, etc.) distributes risks and provides options for adaptation to environmental change (Luque Agraz and Doode Matsumoto, 2009). Likewise, the Yabarana people of Venezuela rely on hunting, gathering, fishing, agriculture and animal husbandry. Their use of these different sources of subsistence shifts according to seasonal and environmental conditions (Gonzalez Tabarez, 2009). This ability to rely on a diversity of food sources is a cultural asset and a safety measure that allows the Comcaac, Yabarana and other indigenous peoples to cope with climatic shifts and changes.

Traditional knowledge is also a vital component of indigenous peoples' ability to respond to and manage environmental change (Berkes, Colding and Folke, 2000). In Columbia, for example, the shamans of the Tukano people rely upon their traditional knowledge of local biodiversity and climate to schedule hunting expeditions during periods of species abundance, and to limit them during droughts and other unexpected environmental changes (Berkes, Colding and Folke, 2000). In the Puno region of Peru, indigenous peoples use traditional knowledge about the environment and about wildlife (i.e. frequency of rains, flowering of certain plants, appearance of certain animals, mating of animals, incidence of pest infestations, etc.) to determine when to plant and when to harvest (Claverias, 2000).

Agricultural traditional knowledge has also proven to be an invaluable adaptation tool for indigenous peoples in the Americas. In coping with excessive or low rainfall, drought and other environmental changes, indigenous peoples throughout the Americas rely on a diversity of crops, varieties and planting locations. This serves as a safety measure to ensure that, in the face of severe environmental change, some crops will survive. The Chipaya people of Bolivia monitor the wind, snow, clouds and stars to determine what species to plant and when and where to plant them (Llosa Larrabure, Pajares Garay and Toro Quinto, 2009). In Chile, the Mapuche have a complex traditional seed bank for conserving genetic variability within species (Chehuaicura, Thomet and Perez, 2010). Such diversity provides security for the Mapuche against environmental change and other stresses.

Traditional knowledge about ocean and marine life is also important for adapting indigenous livelihoods to climate change. This indigenous knowledge is used to direct fishing so as to increase catches and target specific species at particular times during periods of environmental stress (Riedlinger and Berkes, 2001; Moore and Huntington, 2008).

Traditional institutions also contribute to a community's adaptive capacity and resilience (Robards and Alessa, 2003; Ford, Smit and Wandel, 2006). In the Americas, indigenous peoples rely on traditional modes of social organization and coordination to achieve shared goals. Successful adaptation relies on the ability to produce and exchange resources, especially during times of environmental stress (i.e. hurricanes, floods, disasters, etc.).

The Weensuk Cree in Canada note that while they have successfully adapted to change in the past, the rapidity and pervasiveness of social and environmental change is presenting a significant challenge to their well-being and to the sustainability of their livelihoods (Lemelin et al., 2010). A similar pattern is also observed with the Wemindji Cree on the eastern side of James Bay (Peloquin and Berkes, 2009).

Chapter 7. Arctic/ Northern Polar Regions: Regional Report

Key points

- Indigenous knowledge and the first-hand experiences of Arctic communities are an essential foundation for the formulation of locally relevant adaptation strategies.
- In the harsh Arctic environment, indigenous knowledge provides the basis for risk management, as well as safety and survival skills. Erosion of these skills among younger generations is a concern for elders, given the increase in weather unpredictability due to climate change.
- Indigenous Arctic communities are providing systematic observations of climate change impacts, which complement scientific data and frame local adaptation efforts.

7.1. Context

In the IPCC's Fourth Assessment Report (AR4), the chapter dedicated to polar regions includes a specific case study (15.6.1) entitled 'Traditional Knowledge for Adaptation'. This study draws attention to the extensive and detailed knowledge of Arctic peoples regarding their natural environment, including natural resources. It pointed out that indigenous peoples' knowledge is increasingly valued as a complement to scientific knowledge as it expands and deepens understanding of vulnerability and offers additional opportunities to set in place appropriate measures for climate change adaptation.

Since publication of the AR4, an abundance of research based on indigenous knowledge has been conducted throughout the circumpolar north, notably

due to the impetus of the International Polar Year 2007–2008, sponsored by the International Council for Science (ICSU) and the World Meteorological Organization (WMO) (Krupnik et al., 2011). This research has greatly advanced understanding of the significance of traditional knowledge for:

- First-hand documentation of climate change effects and responses based on observations, understandings and interpretations of Arctic peoples;
- Community-based assessments of risks and challenges to human security associated with climate change; and
- Co-production of knowledge of vital importance for understanding climate change risks, vulnerability and adaptation, through the collaboration of indigenous peoples with scientists, both natural and social.

7.2. Climate change in the Arctic and impacts on indigenous peoples

The Arctic is experiencing some of the most rapid and severe changes in climate on Earth (Post, 2011). Temperatures are increasing at a rate twice the global average. Arctic sea ice cover at the end of the melt season has hit record lows, and this downward trend is accelerating (Stroeve, 2009; Stroeve et al., 2012), Over the next century, climate change is expected to accelerate, contributing further to the major physical, ecological, social and economic changes already underway in the region (MacDonald, 2010).

A wide range of impacts are being reported. The timing, length and character of the seasons are changing, making weather patterns less predictable (Weatherhead, Gearheard and Barry, 2010). Receding and thinning ice is making travel on frozen seas, rivers or lakes increasingly hazardous (Riedlinger and Berkes, 2001; Laidler, 2009; Krupnik et al., 2010), while melting permafrost changes spring runoff patterns, destabilizes roads and community infrastructure, and renders traditional storage in permafrost cellars obsolete (Evengard and McMichael, 2011). Coastal communities are severely threatened by erosion as diminishing pack ice leaves coastlines exposed to increasingly severe storms, leading in some cases to community relocations (Bronen, 2009).

Increased variability in snow and ice conditions is having a profound effect on the distribution and migration patterns of many animals, including emblematic Arctic species such as the bowhead whale (*Balaena mysticetus*) (Sakakibara, 2010) and the polar bear (*Ursus maritimus*). More southerly species are moving

north, such as willow trees (*Salix* spp.), beavers (*Castor canadensis*) and elk/moose (*Alces alces*), while traditional mainstays of Arctic economies, including species of fish and seals, are also on the move, leading to shifts in subsistence strategies by local peoples (Berkes and Jolly, 2001; Mustonen, 2005). This has implications for food security and sovereignty (Ford, 2009), which in turn bear significant health implications for indigenous peoples (Ford et al., In press).

Reindeer herding – the millennia-old tradition of more than 20 different indigenous peoples across the circumpolar North – is also being challenged by climate change (Oskal et al., 2009; Magga et al., 2010). Changing weather and shorter winters are altering reindeer and caribou migration and feeding patterns (Mustonen, 2005), while shrubs are moving northward into the barren tundra areas, making access to food a challenge for the animals (Sharmal, Couturier and Côté, 2009). Forest fire frequency appears to be increasing, negatively impacting terrestrial fauna, modifying their migratory patterns, and causing geographic and temporal changes in indigenous livelihood practices (Parrotta and Agnoletti, 2011).

Climate change is also accelerating other transformations in the Arctic. Industrial development is expanding in response to increasingly accessible non-renewable resources such as oil, gas or minerals (Hovelstrud, Dallmann and Amundsen, 2008; Leichenko and O'Brien, 2008; Lee, 2011), and the opening up of shipping corridors through the increasingly accessible Northwest and Northeast Passages (Ragner, 2008). Climate change may also open up new opportunities for industrial scale fishing as fleets follow fish stocks, moving northwards into Arctic waters (Highleyma, Taylor and Mel'nichuk, 2011). An upsurge in Arctic tourism has already begun, as the region becomes increasingly accessible to ice-strengthened surface vessels, with or without icebreaker escorts (Lamers and Amelung, 2010).

Through such changes of historic proportion, the Arctic offers an early example of the profound social-ecological shifts beginning to occur in many other regions of the world, as global climate change and globalization unfold (Axworthy and Hurley, 2010).

7.3. Indigenous observations of changing weather and climate

Adaptation to climate change has lately emerged as a priority for the global community (Parry et al., 2009). If policies and actions in support of adaptation are to be effective, however, they must be attuned to the on-the-ground

realities of communities, as well as their priorities and aspirations (Anchorage Declaration, 2009; Reid et al., 2009). This presupposes a solid engagement with local community members, who are uniquely placed to share their traditional knowledge on the nature of climate change affects, specific vulnerabilities and opportunities for adaptation (Krupnik and Ray, 2007).

Recognition of the need for direct community involvement is all the more important in the Arctic due to the unique livelihoods and cultures of the indigenous peoples (Huntington, 2009; Pearce et al., 2009). Decisions with respect to the climate change adaptation requirements of indigenous hunters, fishers or herders in the Arctic, must be grounded in a thorough understanding of what it means to live on and from the land, sea and ice.

For over two decades, Arctic indigenous men and women have been reporting environmental changes resulting from a shifting climate (Huntington et al., 2004; Huntington et al., 2005; Krupnik and Jolly, 2002). At numerous locations across the Arctic, indigenous communities have been witnessing increasingly erratic weather conditions that confound their efforts at weather prediction. Mabel Toolie of St Lawrence Island chose to express this unsettling circumstance by reporting 'the Earth is faster now' (Krupnik and Jolly, 2002). Yup'ik from the Bering Sea coast of south-western Alaska give voice to their dismay by declaring that 'the weather is becoming an incessant liar' (Fienup-Riodan and Rearden, 2010: 317). Yukaghir elders from Russian Arctic say that 'we have stopped trusting nature and nature has stopped trusting us' (Shadrin, 2009). No matter how it may be expressed, the phenomenon of changing, increasingly variable and unpredictable weather resonates from one Arctic community to the next across the circumpolar North.

Based on their knowledge and experience, Inuit hunters of Clyde River, Nunavut, Canada, report increasingly erratic weather and wind conditions that undermine their traditional weather forecasting (Gearheard et al., 2010). These changes have been particularly evident to hunters from the 1990s onwards, with experienced traditional weather forecasters remarking that they feel they have 'lost their skills' (Gearheard et al., 2010: 274). Some hunters now pack additional gear when heading out on the land, recognizing that the weather may suddenly and unpredictably change. Hunter reports of a specific turning point in weather predictability coincide with recent meteorological analyses showing a significant decrease in weather persistence in the Arctic from the 1990s onwards (Weatherhead, Gearheard and Barry, 2010; see Chapter 2.5 in this volume).

One change inscribed in the landscape relates to what the Inuit refer to as *uqalurait*, snowdrifts that form parallel to the wind and that serve as a navigational aid for hunters. In the past, *uqalurait* pointed in a consistent direction dictated by the dominant wind. When visibility was poor, hunters could plot a reliable course in

relation to the orientation of the *uqalurait* in order to arrive at destination. Today, however, the dominant wind is reported to have shifted and wind direction is more variable. Hunters now only rely on *uqalurait* for navigation, if they have been on the land on a regular basis and have kept track of shifts in wind and the orientation of *uqalurait*. Young or inexperienced hunters risk getting lost because they may not be aware of this recent variability and may assume that the *uqalurait* are as reliable as in the past (Gearheard et al., 2010).

In a vast and sparsely populated Arctic landscape, persons who lack appropriate knowledge, experience and preparation may find themselves in potentially life-threatening circumstances due to inclement weather, sub-zero temperatures, violent winds, rough waters or treacherous ice conditions. Arctic indigenous peoples rely on traditional knowledge to seek sheltered waters when storms arise at sea; to build snow houses when trapped by unexpected blizzards; or to seek out emergency food for their herds when mid-winter thaw and freeze lock pastures under sheets of ice. For this reason, Arctic peoples have always considered traditional knowledge about the land and associated survival skills to be of primordial importance.

Erosion of traditional knowledge and skills, on the other hand, increases vulnerability and risk. Older members of indigenous communities often worry when young persons are out on the land (Dowsley et al., 2010). With inadequate knowledge and experience, youth may poorly assess dangers, take ill-advised risks, and not know how to respond when accidents occur. In the past, before young men were allowed to venture out on their own, Yup'ik elders taught them in the communal men's house about the ocean and its dangers. Yup'ik elders are concerned about the lack of such teaching today (Fienup-Riordan and Rearden, 2010).

Given that climate change is expected to increase the frequency and intensity of extreme weather events, the mastery of survival skills embedded in traditional knowledge is increasingly important in rapidly changing and potentially life-threatening circumstances (Aporta, 2009; Laidler et al., 2009; Aporta, 2010; Ford, Pearce et al., 2010; Laidler et al., 2010; Aporta and MacDonald, 2011).

But even as Arctic societies reaffirm the key role of traditional knowledge for climate change adaptation, the unpredictable and unprecedented nature of climate change may shake a society's confidence in its knowledge of the natural milieu. Sea ice trails used for generations become treacherous, traditional indicators of seasonal change become unreliable, and familiar animals do increasingly unfamiliar things. In this context, climate change may contribute to a growing sense of uncertainty and a troubling suspicion that the knowledge of elders may no longer represent an unwavering guidepost for life on the land. Dowsley et al. (2010) found that women in Clyde River and Qikiqtarjuaq,

Nunavut, Canada, were more fearful of going out on the land due to the unpredictability of weather and sea ice conditions.

Ford et al. (2007) argue, however, that even though climate change may call into question specific elements of traditional knowledge, the mainstays of life on the land in the Arctic will remain the same. Indeed, in-depth knowledge of the land, familiarity with home territories, and basic skills for safety and survival will become all the more essential in the face of changing conditions.

As suggested by Takano (2004 cited in Ford et al., 2007), elements of knowledge *per se* may be of lesser importance than the cultural attitudes and values that shape the ways in which knowledge may be acquired, transformed and deployed. Yup'ik elders continue to underline the importance of not giving up and not showing fear, especially when accompanied by a younger companion who might panic (Fienup-Riodan and Rearden, 2010). The true wisdom of indigenous knowledge may in fact be the enduring values of patience, persistence, calmness, respect for elders and respect for the environment, which allow indigenous communities to remain resourceful and resilient in a changing world (Ford et al., 2007).

This may explain in part the resounding aplomb of Arctic indigenous peoples when questioned about the future impacts of global climate change. They commonly emphasize that their environment has always changed and is always changing (Fienup-Riordan and Rearden, 2010). No matter what change may come in the future, they express the conviction that their knowledge and skills will allow them to adapt, as countless generations have successfully adapted before them (Cochrane, 2008; Lynge, 2009).

7.4. Indigenous knowledge and disaster preparedness

Global climate change is expected to increase the frequency and intensity of extreme climatic events, which may in turn increase the risk of natural disasters. Indigenous knowledge of high-risk events and the sharing of lessons learned prepare communities for potentially disastrous circumstances that may occur in the future.

George et al. (2004) recorded the observations, lessons learned and subsequent preparedness measures adopted by Inupiat hunters of Barrow, Alaska, USA, in response to two exceptional and near disastrous events. Major failure of the shorefast ice, which serves as the platform for the emblematic Inupiat

bowhead whale hunt, put scores of hunters at grave risk on two occasions in the twentieth century. On one occasion, hunters had to scramble to get back to land, abandoning equipment and camps, when the vast landfast ice shelf suddenly and unexpectedly shattered due to pressures exerted by wind and current-driven pack ice. On another occasion, hunters drifted out to sea on a large ice platform that unexpectedly broke away from the coast. Fortunately, no lives were lost on either occasion. But from these near disastrous events, the Inupiat took home key lessons that they continue to transmit about the challenges and risks of hunting in a dynamic sea ice environment. These extreme learning events bolster Inupiat knowledge of vulnerability and risk, and heighten community disaster preparedness in an environment that will become increasingly unstable as climate change advances. Arctic reindeer-herding peoples are equally concerned about climate-related disasters that may threaten people or the survival of their herds (see Section 4.3 on the Sami of northern Sweden).

7.5. Indigenous observing systems

One of the most innovative developments since the IPCC AR4 has been a multiplication and expansion of collaborative research efforts involving indigenous peoples and natural and social scientists (Huntington, 2011). These emerging partnerships build upon a long history of joint research and management that, in the Arctic, date back several decades to the land claims processes in northern North America in the 1970s and 80s (see Section 5.4).

Krupnik and Jolly (2002) provide a collection of early works on indigenous observations of change, including climate change, with revealing titles such as 'We can't predict the weather like we used to' (Jolly et al., 2002). The compendium includes detailed documentation of indigenous knowledge of climate change effects from across the North American Arctic and Subarctic: Yupik from the Bering Sea coast of Alaska (Krupnik, 2002); Gwitchin and Inupiat/Inuvialuit from the Alaska-Canada borderlands (Kofinas, 2002); and Inuit from the western, central and high Arctic, Nunavut, Canada (Jolly et al., 2002; Fox, 2002).

A further example of continuous observation of ecological change is provided by the Nenets in Northwest Russia, who report increases in the height of willow and alder shrubs (*Salix* spp., *Alnus fruticosa*) in the tundra zone (Forbes and Stammler, 2009). The reports from the Nenets are independently confirmed by groups of herders on both sides of the Polar Urals, travelling along traditional migration routes used for decades. They are also linked to discernible changes in reindeer management in response to increases in shrub height. Specifically,

herders now in their fifties observe that shrub thickets, which were mostly less than 1 m tall in the 1970s, in many cases now overtop the antlers of their reindeer (>2 m). In response, they need to keep their animals out of the tall, dense thickets to avoid losing sight of them during the rapid summer migration, or they will lose valuable reindeer (Forbes and Stammler, 2009; Forbes, Macias-Fauria and Zetterberg, 2010). In other words, indigenous observers have their own good reasons to develop and maintain observations of their environment, which may not be quantitative, but are no less accurate and detailed.

Recent work on indigenous knowledge and climate change observation has been completed within the framework of the International Polar Year (IPY) (Hovelstrud, Krupnik and White, 2011). One such project, Sea Ice Knowledge and Use: Assessing Arctic Environmental and Social Change (SIKU), involved the establishment of daily ice and weather observations by indigenous monitors in 10 communities in Alaska, Canada and Russian Chukotka, between 2006 and 2009 (Krupnik et al., 2010). This community-based monitoring was continued for a fourth year in three Alaskan villages, thus providing an uninterrupted record of indigenous observations covering four consecutive ice seasons. Overall, the SIKU project produced several hundred pages of local indigenous observations, organized in more than 150 monthly logs (Hovelstrud, Krupnik and White, 2011).

The breadth and accuracy of these observations can be attributed to the vast and age-old Inuit knowledge of sea ice and their highly specialized lexicon. Krupnik and Weyapuk (2010: 334) report over 120 Inupiaq terms for sea ice and associated vocabulary from Wales, Alaska, including almost 75 terms for types of sea ice and ice conditions. Each term is used to designate a meaningful and distinct phenomenon, and thus illustrates the refinement and subtlety with which Inupiat are perceiving and interacting with their local ice environment. Sea ice vocabularies of similar magnitude and sophistication are reported from Inuit communities across the circumpolar North (Fienup-Riordan and Rearden, 2010; Johns, 2010; Krupnik and Muller-Wille, 2010; Krupnik, 2011).

These elaborate vocabularies also constitute particularly fine-grained and high-resolution conceptual frameworks for observing ice environments and noting subtle transitions and trends. Many sea ice terms are bundled with information about hazardous conditions and potential dangers. Safety and survival on the sea ice is in part managed through the group's ability to share critical information rapidly and efficiently. Local languages, being site-specific, serve as vehicles for sharing knowledge and experiences about a dynamic and potentially risky environment that is now subject to rapid and unpredictable change due to climate change (Krupnik and Weyapuk, 2010).

In another IPY project, called Igliniit, Inuit hunters recorded observations on wildlife, sea ice, weather or other environmental phenomena as they travelled across the land (Gearheard et al., 2011). These observations were systematized, spatially accurate and registered on the spot through the development of a GPS/minicomputer device that hunters affixed to their snowmobiles.

Collaborative initiatives such as these, which bring together indigenous and scientific knowledge, contribute importantly to climate change monitoring and adaptation. They provide meticulous and systematic local observations that are informed by indigenous experience and understandings, and further enriched with relevant information related to subsistence livelihoods and community concerns and needs.

Chapter 8. Small Islands: Regional Report

Key points

- Small island societies have lived for generations with considerable and often sudden environmental change. The traditional knowledge and related practice with which small island societies have adapted to such change are of global relevance.
- Areas in which small island societies have developed adaptation-relevant traditional knowledge include natural disaster preparedness, risk reduction, food production systems and weather event forecasting.
- In many small island contexts, the transmission and application of traditional knowledge is under threat from changes in consumption and migration patterns, as well as from the lack of recognition of traditional knowledge in the formal educational system.

8.1. Context

The IPCC's Fourth Assessment Report (AR4), released in 2007, stated that small islands share a set of particular and unique vulnerabilities to climate change and sea-level rise. The AR4 related this vulnerability to the geophysical characteristics of small islands and to social and demographic factors. In its introduction to Chapter 16, the AR4 notes:

> *[Many small islands] comprise small land masses surrounded by ocean, and are frequently located in regions prone to natural disasters, often of a hydrometeorological and/or geological nature. In tropical areas they host relatively large populations for the area they occupy, with high growth rates and densities. Many small islands have poorly developed infrastructure and limited natural, human and economic resources, and often-small island populations are dependent on marine resources to meet their protein*

> *needs. Most of their economies are reliant on a limited resource base and are subject to external forces, such as changing terms of trade, economic liberalisation, and migration flows.*
>
> (IPCC, 2007: 690–91)

While the AR4 acknowledged the existence of a set of physical and socioeconomic factors contributing to the particular vulnerability of small islands to climate change, it did not discuss in detail the contribution made by traditional knowledge systems and related practice towards making original settlement and continuous habitation of small islands possible. While noting that the adaptive capacity of small islands is generally low given the constraints discussed above, the AR4 concedes that 'traditionally there has been some resilience in the face of environmental change (2007: 691).' Suggesting that traditional knowledge in the small island context is an area requiring further study, the AR4 notes that:

> *With respect to technical measures, countries may wish to pay closer attention to the traditional technologies and skills that have allowed island communities to cope successfully with climate variability in the past. However, as it is uncertain whether the traditional technologies and skills are sufficient to reduce the adverse consequence of climate change, these may need to be combined with modern knowledge and technologies, where appropriate.*
>
> (IPCC, 2007: 712)

The AR4 noted that small islands have legitimate concerns about their future given observational records, their experience of climate variability, weather patterns and climate model predictions, and that 'many small islands have already perceived a need to reallocate scarce resources away from economic development and poverty alleviation, and towards the implementation of strategies to adapt to the growing threats posed by global warming' (IPCC, 2007: 690). During recent years, small island developing states (SIDS) – a grouping of 52 small island countries and territories in the tropics and sub-tropics – have increasingly voiced their concern over the likely impact that climate change will have on their prospects for sustainable development. This concern has been reflected at the highest level of government within SIDS, as well as internationally.

In 2010, in the context of the five-year review of the *Mauritius Strategy for the further implementation of the Barbados Programme of Action for the Sustainable Development of SIDS*, the United Nations General Assembly 'Acknowledge[d] that climate change and sea-level rise continue to pose a significant risk to small island developing states and their efforts to achieve sustainable development and, for some, represent the gravest of threats to their survival and viability' (United

Nations, 2010: 2), further noting that climate change would likely have an adverse impact on small island economies and sustainability given the projected severe impacts on key sectors of small island economies such as tourism.

8.2. Small island vulnerabilities and impacts

Post-IPCC AR4 literature has highlighted the particular set of shared vulnerabilities of small islands, while acknowledging the existence of considerable differences between individual island contexts both at the regional and global scale. Summarizing the challenges facing Pacific island nations, Mortreux and Barnett (2009) note that '[e]xisting and increasing concentrations of greenhouse gases seem likely to result in increases in mean and extreme air and ocean temperatures, rising sea levels, changes in precipitation patterns, and increasing intensity of extreme events.' These changes are expected to impact the livelihoods and cultures of Pacific Island peoples in important ways, for instance, by altering fish stocks, increasing coral bleaching, facilitating saline contamination of freshwater, increasing risk of diseases, and hindering agricultural productivity (Mortreux and Barnett, 2009: 105).

Other consequences of climate change that impact the livelihoods of small island peoples, include: invasion of alien species; loss of coastal land and infrastructure due to erosion, tidal surges and increase in frequency and severity of cyclones; destruction of coral reefs and marine ecosystems from warming and acidifying oceans; decrease in food security due to the loss of food sources – such as fisheries due to coral bleaching, livestock and agricultural crops from extreme temperatures, changes in the seasons and severity of rainfall; loss of drinkable water through changes in precipitation, sea-level rise and inundation by sea water; and increase in infectious diseases, including dengue fever, malaria, cholera and diarrheal outbreaks (Galloway McLean, 2010).

8.3. Traditional knowledge for adaptation

For small island peoples, adaptation to environmental change is not a recent phenomenon, especially given the constraints of the islands' physical dimensions and relative geographical isolation. Traditional knowledge systems and practices were indispensable in making the original settlement of small islands possible, and subsequently in ensuring continuous human habitation, in spite of the islands' considerable past and present exposure to both anthropogenic and non-anthropogenic environmental variation and stress. The rapid Polynesian expansion into the remote Pacific islands over a period of no more than a few

centuries (Kirch, 2010) is a testament to the existence of traditional knowledge systems capable of a remarkable degree of adaptation. These systems allowed not only extended journeys over open ocean, but also the colonization and successful settlement of highly diverse islands across a vast spatial and climatic range – from New Zealand in the south to Hawaii in the north.

Given the high degree of cultural, biological and geophysical diversity among small islands, approaches to adaptation are highly diverse. In the absence of a single 'small island context', Damon and Mondragon suggest that 'approaches to environments and societies in small islands contexts require careful consideration of local familiarity with ecological change, with special attention to existing long-term trends in the adaptive capacity of social and environmental milieux' (see Box 4.2).

Commenting on the role of cultural practices and values in determining adaptive responses to environmental change in the archipelago of the Marshall Islands in the central Pacific, Kuruppu (2009: 800) notes that:

> *Recent scholarship on climate adaptation has overlooked the influential role of cultural values in structuring people's adaptive capacity (Berkes and Jolly, 2001; Hulme et al., 2007; Leduc, 2006). As Sahlins (1976) asserts the material and cultural are inseparable; material goods or assets are embodied in some coefficient of culture (ideas, values, symbols, etc.) and is enacted through social processes.*

Considering the many present-day social and ecological challenges, traditional knowledge constitutes a strong foundation for locally appropriate approaches to climate change adaptation (IUCN 2008). Small island indigenous peoples seek ways to address climate change consequences based on their own traditional knowledge, their own terms, and within their own traditional decision-making processes (MSV 2007; AOSIS, 2009).

Under the harsh conditions imposed by the low-lying atoll environment, traditionally practices for the management of land and biodiversity create an essential buffer against environmental extremes. Discussing the observations of elders returning to Rongelap Atoll following decades of resettlement enforced as a consequence of the nearby nuclear test at Bikini, Bridges and McClatchey (2009: 143) describe how:

> *without exception, the men noted that the productivity of the land had plummeted. They told us that the trees, shrubs and even herbaceous crops that had been left untended were in poor condition and in need of management […] We were shown how regular human interaction with the environment increased the productivity of the native as well as the alien plants in the same environment.*

The authors further note how the Ronglap community

> *and their ancestors have conducted a constant land expansion campaign that requires regular maintenance. When people are withdrawn from the islands, as has happened at Rongelap because of nuclear contamination, the conditions begin to revert. To the untrained eye or the unprepared scientist this would appear to be erosion of an island and possibly the effects of global climate change.*

Traditional calendars

Based on a combination of locally specific environmental, seasonal, climatic and astronomical observations, traditional calendars have played an important role in how indigenous and local small island communities interpret and respond to shifts in weather and climate patterns. Such calendars not only relate to annual cycles with recurring seasonal patterns, but may also incorporate patterns of weather and climate on a larger multi-annual time scale, as is the case in Torres Islands:

> *[…] there may be a certain synchronization of ENSO-related (7 to 8 year) periods of drought and above-average rainfall which lead to increased food production that is tied into important ritual activity, namely, ceremonial feasting related to special status-alteration rituals that only take place once or twice during the average lifetime of a person. Specifically, ENSO-related periods of drought tend to be related with little to no production of ceremonial yams and kava, while wetter years produce the contrary effect* [see Box 4.2].

Another example of the application of traditional calendars is the use of lunar observations in the organization of local artisanal fisheries practices and weather forecasting in Cape Verde in the Eastern Atlantic. Knowledge of the lunar cycle is incorporated into a 'mental map of every fisherman, including the coordinates of each [fishing] ground based on landmarks' (Ilic, see Box 4.4). Due to its influence on sea tides, fishers regard the moon as a compass. Ilic further notes how the lunar observations play a role in traditional weather forecasting: 'If there is a green circle around moon, weather will be fresh and rainy; if it is white one, it will be windy' (Box 4.4).

Traditional lunar-based calendars are also important in the structuring of traditional agricultural practices. In Tuvalu, traditional seasonal calendars have been used as the basis for interpreting weather, including extreme weather events (Resture, see IPMPCC, 2011).

Weather and extreme event forecasting

Many small island environments are prone to rapid and severe changes in environmental conditions due to drought, hurricanes/cyclones, earthquakes and tsunamis. In response, small island societies have developed highly complex systems to enhance resilience in the face of such rapid and significant changes. In Tonga (Faka'osi, see IPMPCC, 2011) and Tuvalu (Resture, see IPMPCC, 2011), these include a wide range of traditional forecasting techniques relating to anticipating extreme weather events. Such techniques rely upon observations of the sea and lagoon (e.g. the sizes, strengths and sounds of waves, the colour and smell of the water, and the amount of seaweed deposited on the beach); the sky (e.g. type and colour of clouds, the appearance of the moon in a particular way); and the winds (e.g. primarily direction and speed). Other key indicators are phenology (e.g. the abundance of particular fruit like mangoes and breadfruit is a sign of strong wind or heavy rain, and a rise in the groundwater table of taro gardens is an indicator of rising seas); bird and animal behaviour (e.g. low-flying albatross is a sign of poor weather, and animals seeking higher ground is a warning sign of approaching tsunami); and insects and arachnids (e.g. their appearance indicates the approach of unfavourable weather).

In the Torres Islands of Vanuatu, recurring and often dramatic environmental change has shaped the social and spatial organization of local communities. Damon and Mondragon (2011) note that islanders:

> *are used to the shoreline and even parts of the lowlands on the Torres experiencing sometimes dramatic shifts in appearance. These shifts often have extreme consequences for lowland soil fertility, vegetative growth and horticulture, in addition to sometimes provoking violent changes to local hydrodynamics (within the mangrove lagoon, for instance). But on the whole, over their 3000-year history local islanders have learned to adapt to such abrupt transformations in coastal dynamics. This adaptability is further enhanced by the constantly shifting nature of local settlements* [see Box 4.2].

Having suffered the occurrence of two powerful earthquakes, which drastically altered the coastal morphology of Linua Island in 1997 and 2008, the example of Torres Islands illustrates how a small island culture inhabiting a seismically very active area has developed a high degree of resilience to even sudden and violent shifts in coastal morphology and hydrodynamics.

Food production and storage

Another important body of traditional knowledge that informs climate change adaptation strategies for small islands relates to local traditional food production systems. The high degree of reliance on local agrobiodiversity by indigenous small island populations is inextricably linked to the complex traditional knowledge systems governing local food production.

Indigenous small island agricultural practices maintain the ecological functions of small island environments, unlike urban development or aquaculture, such as shrimp farming, which have destroyed the ecological functions of mangrove ecosystems in a number of small island contexts (Spalding et al., 2010).

Indigenous agricultural practices in small islands have been developed to amplify particular qualities of the local environment in order to optimize food production. In Rongelap Atoll in the Republic of the Marshall Islands, taro pits are dug in the ground-water lens, and are lined with successive layers of plants, organic mulch and coral rubble. They constitute an important feature of Pacific atoll traditional agricultural practice of managing taro pits as 'humidity pockets' to simultaneously increase food production and reduce consumption of freshwater (Bridges and McClatchey, 2009) (see Section 4.5 on the Torres Islands). The principle of distributing environmental risk appears as a central element in small islands indigenous resilience strategies, whether it takes the form of the scattering of food production sites in the Torres Islands, or the diversity of sources and traditional preservation techniques of post-disaster foodstuffs found in Tuvalu.

Other aspects of traditional food production systems that enhance local capacity to address consequences of climate change are traditional preparation and storage of emergency foods (Bourke and Harwood, 2009). In the islands of Tuvalu in the South Pacific, these foods are employed to enhance resilience by stocking each family's food storage (*kaufata*) with enough preserved foods to last them through a cyclone or drought event (Resture, see IPMPCC, 2011). In low-lying atolls of the Marshall Islands in the central Pacific 'traditional knowledge about food storage and fermentation of local root crops not only provide [s] food security in times of scarcity, but also serve[s] to replenish the nutrient deficient soils for further agriculture' (Butler and Coughlan, 2011).

In the Pacific islands, particular traditional preservation and storage techniques have been developed for local foods that suit local environments and maximize their suitability for long-term storage. Examples include scraped and dried Pandanus (*Tectorius* spp.), dried giant swamp taro (*Cyrtosperma* spp.), boiled/baked, pounded and dried taro (fam. *Araceae*), dried coconut and dried fish (Faka'osi, see IPMPCC, 2011). Traditional

techniques have also been adapted to incorporate modern materials and to provide enhanced protection of stored foodstuffs during the recurring 'King tide' events in Tuvalu fish: 'Today, the Nanumea women community on Funafuti have adapted… by burying a plastic drum and filling it with germinating nuts and/or taros. During King tides, the germinating nuts and taros are safe as they are protected from the rising saltwater by the plastic drums in which they are kept.' (Resture, see IPMPCC, 2011).

8.4. Challenges to traditional knowledge transmission

While the examples discussed in this chapter illustrate the considerable potential for traditional knowledge to contribute to present-day climate change adaptation strategies in small islands, it should be noted that traditional knowledge in the small island context is in many cases rapidly eroding due to the interruption of intergenerational knowledge transmission. There are a number of contributing factors, including the absence of traditional knowledge in the formal school curriculum; the close integration of island societies with the global economy; internal and external migration from smaller rural societies towards urban settlements and from island countries to larger continental economies; and the relatively easy access to imported food and popular culture. Adger et al. (2011: 8) note that:

> *cultures are adapting to new locations and situations and transforming in ways that weaken older cultural forms and render them less visible. In Niue and the Cook Islands, for example, large-scale migration has resulted in more islanders living in New Zealand than in the islands, yet the cultures of New Zealand-based islanders have not been wholly displaced, nor have the cultures of the islands themselves. In both Niue and the Cook Islands, however, reciprocal exchange has been weakened through diverse and sometimes simple processes such as deep freezers curtailing the distribution of fish among households (which would otherwise be shared for immediate consumption); the dominant use of English… the disinterest of youth in traditional ecological knowledge; and the replacement of many traditional food procurement strategies by supermarkets and local shops.*

In their discussion on traditional knowledge in Rongelap Atoll, Bridges and McClatchey (2009) conclude that 'One of the great-unsung losses of recent times has been the widespread abandonment of oral record keeping in the form of chants and songs that are able to codify complex pieces of information and pass this across multiple generations'. Resture urges that

immediate attention be given to address the breach in intergenerational traditional knowledge transmission:

> *Reviving traditional knowledge that has proven its applicability for hundreds of years can be achieved through introducing it into the school curricula… Children learn this knowledge at a very young age, and from this age onwards, are able to develop their traditional skills in weather forecasting, food preservation, and risk reduction strategies. Blending this with the contemporary science curricula would allow them to develop what we may call a 'hybrid' of skills… to allow them to address disaster risks effectively.*
>
> (see IPMPCC, 2011)

Discussing the decline of traditional knowledge transmission in Tonga, Faka'osi (see IPMPCC, 2011) notes: 'An educational system that ignores traditional values is one that will unfortunately produce a generation ignoran[t] of their roots and identity.'

Chapter 9. Conclusion

Indigenous peoples and rural communities are vulnerable to the impacts of global climate change, not only because they depend on resources and the environment for their living, but also because they are often marginalized from decision-making processes and places of power. This said, they are neither passive nor without ways and means. They engage actively with their natural environment in their day-to-day lives, are experienced and attentive observers, and have accumulated sizable and sophisticated bodies of knowledge and practices about their environment, its variability and transformation. This knowledge and know-how provides the basis for people's livelihoods, which are in turn at the centre of societal efforts to adapt to variability and change. Indigenous knowledge can therefore provide important insights into processes of adaptation.

The significance of indigenous knowledge becomes all the more evident once it is acknowledged that indigenous peoples and local communities have been confronted with environmental variability and unpredictability for centuries. They have developed a wide variety of technical, social and economic responses that constitute the basis for their resilience in the face of change. Even though the transformations brought about by global climate change will undoubtedly surpass the lived experience of everyone, including indigenous peoples, a strong case can nonetheless be made for recognising indigenous resilience as the basis for indigenous adaptation, and for fostering their fullest expression.

Government policy and action should preserve and boost indigenous resilience. This may include policies to preserve strategic choices and fallback options by supporting the continuation of nomadic or semi-nomadic lifestyles, securing access and ownership over traditional territories, removing unnecessary restrictions on resources, and fostering diversity of domestic crops and animals, among other things.

Such policies will need to be formulated on the basis of further interdisciplinary action research that brings together indigenous knowledge holders and scientists, both natural and social, to build mutual understanding and reinforce dialogue. It is essential that indigenous peoples – who are active resource users and bearers of traditional knowledge – play a central role in this process. Recent partnerships between indigenous peoples and scientists are producing new knowledge in response to the emerging challenges of climate change. This co-produced knowledge that derives from synergies between both systems of knowledge may point the way forward to promising and productive ways to address the complexities of climate change adaptation.

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When considering climate change, indigenous peoples and marginalized populations warrant particular attention. Impacts on their territories and communities are anticipated to be both early and severe due to their location in vulnerable environments, including small islands, high altitude zones, desert margins and the circumpolar Arctic. Heightened exposure to negative impacts, however, is not the only reason for specific attention and concern. As many indigenous societies are socially and culturally distinct from mainstream society, decisions, policies and actions undertaken by the major group, even if well-intended, may prove inadequate, ill-adapted and inappropriate. There is therefore a need to understand the specific vulnerabilities, concerns, adaptation capacities and longer-term aspirations of indigenous peoples and marginalized communities the world over. Indigenous and traditional knowledge contribute to this broader understanding.

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