Adapting to health impacts of climate change: a study of UNFCCC Annex I parties

A C Lesnikowski¹, J D Ford¹, L Berrang-Ford¹, J A Paterson¹, M Barrera² and S J Heymann²

¹ Department of Geography, McGill University, 805 Sherbrooke Street West, Montreal, QC, H3A 2K6, Canada
² Institute for Health and Social Policy, McGill University, 1130 Pine Avenue West, Montreal, QC, H3A 1A3, Canada

E-mail: alexandra.lesnikowski@mail.mcgill.ca

Received 18 July 2011
Accepted for publication 10 October 2011
Published 31 October 2011

Abstract

Adapting to the health effects of climate change is one of the key challenges facing public health this century. Our knowledge of progress on adaptation, however, remains in its infancy. Using the Fifth National Communications of Annex I parties to the UNFCCC, 1912 initiatives are systematically identified and analyzed. 80% of the actions identified consist of groundwork (i.e. preparatory) action, with only 20% constituting tangible adaptations. No health vulnerability was recognized by all 38 Annex I countries. Furthermore, while all initiatives affect at least one health vulnerability, only 15% had an explicit human health component. Consideration for the special needs of vulnerable groups is uneven and underdeveloped. Climate change is directly motivating 71% of groundwork actions, and 61% of adaptation initiatives are being mainstreamed into existing institutions or programs. We conclude that the adaptation responses to the health risks of climate change remain piecemeal. Policymakers in the health sector must engage with stakeholders to implement adaptation that considers how climate change will impact the health of each segment of the population, particularly within those groups already considered most vulnerable to poor health outcomes.

Keywords: climate change, adaptation, health, UNFCCC

Online supplementary data available from stacks.iop.org/ERL/6/044009/mmedia

1. Introduction

It is widely accepted that the climate is changing. Best estimates from the International Panel on Climate Change (IPCC) indicate a rise in average global temperatures between 1.8 °C and 4 °C this century, with implications for natural ecosystems and human communities [1]. Recent simulations suggest that future warming will likely be toward the higher end of the IPCC projections, significantly surpassing the 2 °C threshold believed to be indicative of ‘dangerous interference with the climate system’ [2]. Adaptation will therefore be a critical component of the global response to our changing climate in addition to pressing needs for mitigation [1, 3, 4].

A growing body of academic literature concerning the risks of climate change for health demonstrates a wide range of expected impacts and populations at risk [1]. Extreme temperatures [5], air quality [6], infectious disease [7], extreme weather events [8], and food and water safety and security [9] will pose greater challenges to human health throughout the next century, requiring changes in the way we implement health policy [10]. In 2009, WHO estimates placed excess annual mortality as a result of climatic change at 141 000 by 2004 [11], 85% of which were child deaths. Events such as the 2003 European heat wave, during which over 70 000 heat related mortalities were recorded, further
indicate that disproportionately greater health impacts will fall on vulnerable groups like the elderly [12]. Other groups with heightened vulnerability to climate change include women [13], indigenous groups [14], individuals with pre-existing or chronic conditions [15] and individuals living in poverty [16]. These analyses demonstrate an urgent need to implement responses that reach all segments of society.

Pressure within the health sector for greater prioritization of adaptation has been growing throughout the last decade [1, 17]. WHO Director-General Margaret Chan identified climate change as ‘one of the greatest challenges of our time’, and urged governments to put health at the center of climate policy [18]. In 2008 the World Health Assembly passed a resolution requiring the WHO to create a workplan for addressing climate change [4, 19], with a key objective the strengthening of health systems to cope with the threatsposed, including assessing adaptation needs, evaluating current policies, and prioritizing areas for further support [3].

Adapting to changes in climate will be one of the main challenges facing public health this century [1]. Despite the risks and importance of adaptation however, we only have limited information on current efforts being undertaken to react to and prepare for health impacts of climate change [20, 21]. This is a significant gap constraining our understanding of if and how adaptation is taking place, and hence whether the policy response to date is adequate. This letter aims to address this gap by assessing the status of planned, national-level adaptation efforts among developed countries, but we can’t make assumptions about what has been accomplished based on initiatives discussed in the NCs [22].

There are also several limitations in using the NC5. First, these reports are national-level documents. Results demonstrate that the content of the communications draws heavily on actions occurring either exclusively through or in cooperation with national governments, while adaptations occurring within regional and local jurisdictions are not as widely reflected in these documents. Furthermore, information provided in the NC5 may already be dated given the time gap between document preparation and release by the UNFCCC, with only a general level of detail provided as per NC guidelines (supplementary information, appendix B available at stacks.iop.org/ERL/6/044009/mmedia). These limitations underline our interpretation of results as a proxy for national policy priorities and general trends in health.
adaptation, rather than an exhaustive description of adaptations occurring at every governance level. Given the essential role national governments play in determining policy priorities and distributing resources and support, assessing national leadership on health adaptation is critical in analyzing efforts to adapt. These results are an indicator of the status of adaptation action in the health sector and among health-relevant sectors that can be compared across nations and also monitored over time with the release of subsequent NCs.

2.2. Data analysis

A codebook was designed to quantitatively and systematically extract data related to health adaptation references or initiatives in the NC5 (supplementary materials, appendix C available at stacks.iop.org/ERL/6/044009/mmedia). Any reference or initiative responding to the health vulnerabilities of climate change was considered eligible for inclusion as an observation in the database; multiple observations were included if actions addressed more than one type of action or health vulnerability. We define and categorize health vulnerabilities to climate change as per the IPCC Fourth Assessment Report [22]. These vulnerabilities include extreme temperatures, extreme weather events (e.g. floods, storms, land shifts, or droughts), food safety and security, water safety and security, air quality, and vector and rodent-borne disease. Many of these vulnerabilities also have implications for sectors beyond public health. Adaptations may therefore occur in non-health sectors that have implications for human health, regardless of whether a health component is explicitly identified. Rather than exclude relevant adaptations in non-health sectors, initiatives addressing these vulnerabilities were included whether they occurred in the health sector or in non-health sectors (e.g. spatial planning, agriculture, water). Actions with a deliberate health component were distinguished as having ‘explicit’ recognition of a human health dimension, while all other actions were considered to have an ‘implicit’ health dimension. The results presented in this paper consider explicit and implicit health adaptation together, unless a distinction is noted.

The following variables were collected for each unique reference or initiative: level of action, type of action, status of action, health vulnerability targeted, evidence of explicit linkage to health, evidence of improved health outcomes (for adaptation actions only), acknowledgment of vulnerable groups, target population (urban, rural, or general), sectoral involvement, government jurisdiction, non-government participation, and role of climate change as a driver (primary or mainstreamed). Adaptations were categorized as follows:

- Groundwork actions are considered first steps necessary to inform and prepare for adaptation, but do not explicitly indicate tangible changes in policy or delivery of government services that improve resilience. These types of action consist of impact and vulnerability assessments, research on adaptation options, conceptual tools, stakeholder and networking opportunities, and recommendations for adaptation action. Adaptation actions are understood as changes made to built environments, the delivery of government services, organizational mandates, or regulations in response to predicted or experienced impacts of climate change. Examples of adaptation actions include legislation, departmental development, infrastructure development and technology, public awareness and outreach, surveillance and monitoring, evaluations of program effectiveness, financial support for autonomous adaptation, and medical interventions (e.g. developing and distributing treatments for climate related illness, or revising emergency room standards to accommodate greater influxes of patients following extreme events). Detailed variable and coding definitions are provided in the codebook, available in the supplemental materials (available at stacks.iop.org/ERL/6/044009/mmedia).

All NC5s were reviewed and double coded to ensure consistency in information selection and classification.

Descriptive analyses were conducted in Stata (Intercooled Stata v.9.2, StataCorp). Data were analyzed using unique statements or initiatives as observations, as well as aggregated data at the country level. Results primarily present country counts, indicating the frequency with which specified initiatives are documented among Annex I nations in their NC5. Results are presented using individual observations, however, in cases where the distribution of particular actions is relevant, such as the frequency of adaptation response types.

3. Results

Of 1912 health-relevant groundwork and adaptation actions in the Fifth National Communications, 80% were groundwork actions (1534), with only 378 constituting adaptation interventions. The countries reporting the highest number of initiatives—the United Kingdom, Australia, Finland, and Canada—including over 100 actions. Countries with the lowest number of initiatives (fewer than 25) included Croatia, Iceland, Liechtenstein, Luxembourg, and Slovenia.

3.1. Adaptation remains primarily in the groundwork stage

All 38 Annex I parties reported climate change impact assessments at some stage of completion; 27 countries reported research on adaptation options in addition to risk assessments. Despite emphasis on assessments and research in the NC5, linkages between research and policy outputs are not clearly defined in country reporting. Only 3.5% of adaptation actions documented an assessment or research initiative as the driver of the action.

Reporting on adaptation actions was considerably weaker than on groundwork actions (tables 1–3). Fewer than half of the 38 Annex I countries were found to be responding to any one health vulnerability with adaptation-level action. 11 countries provided descriptions of public awareness and outreach programs addressing extreme heat risks, such as Plan Canicule in France or the Heat Health Watch Warning System
Table 1. Status of response to health risks of climate change. (Note: values indicate numbers of UNFCCC Annex I countries with actions reported in the given category.)

| Health vulnerability       | Level of action |       |       |       |
|----------------------------|-----------------|-------|-------|-------|
|                            | Recognition     | Groundwork | Adaptation |     |
| Extreme heat               | 25              | 26    | 13    |       |
| Extreme cold               | 3               | 3     | 1     |       |
| Air quality                | 17              | 11    | 4     |       |
| UV radiation               | 7               | 1     |       |       |
| General extremes           | 31              | 24    | 13    |       |
| Floods                     | 34              | 32    | 17    |       |
| Storms                     | 21              | 21    | 5     |       |
| Fires                      | 20              | 18    | 5     |       |
| Droughts                   | 22              | 29    | 8     |       |
| Land shifts                | 24              | 23    | 8     |       |
| Water safety and security  | 26              | 32    | 17    |       |
| Food safety and security   | 30              | 33    | 14    |       |
| Infectious disease         | 24              | 18    | 7     |       |
| General health             | 11              | 17    | 3     |       |
| Indeterminate              | 33              | 24    |       |       |

* Indeterminate refers to groundwork or adaptation actions described without explicit reference to any climate change vulnerability.

3.2. Major health vulnerabilities are not addressed by all countries

Flooding was the most widely recognized vulnerability, with 34 countries making statements recognizing increased risk in a changing climate. Food safety and security and general extreme weather events were recognized by 30 countries and 26 countries, respectively, while extreme heat was recognized by 25 countries. The least widely recognized health vulnerability was extreme cold—recognized by only Greece, Canada, and Lithuania. No health vulnerability was recognized by all 38 Annex I countries.

This trend was mirrored in reporting on adaptation actions (table 3), with more countries reporting adaptation action on water, food, flooding and extreme heat than any other vulnerability. 17 countries have pursued adaptation on the issues of flooding and water safety and security, while 14 have taken actions addressing food safety and security. Only 13 countries reported adaptations concerning extreme heat.

3.3. Recognition of the health implications of adaptation is not being widely made in adaptations outside the health sector

Despite all 1912 actions recorded in the database affecting health in some capacity, few demonstrate an explicit recognition of a causal association with human health (table 4). Only 15% of the total number of actions explicitly linked impacts from climate change with the human health dimension of vulnerability. Actions classified as Infrastructure Development and Technology, in particular, rarely recognized the impact of the action on health, with fewer than 1% of the total number of actions making an explicit link. Public awareness and outreach and evaluations had the strongest

Table 2. Groundwork responses to health vulnerabilities of climate change. (Note: values indicate numbers of UNFCCC Annex I countries with actions reported in the given category.)

| Health vulnerability       | Impact/vulnerability assessments | Assessments/adaptation research | Conceptual tools | Stakeholder networking | Recommendation |
|----------------------------|----------------------------------|---------------------------------|-----------------|------------------------|----------------|
| Extreme heat               | 21                               | 3                               | 7               | 2                      | 7              |
| Extreme cold               | 1                                | 1                               | 1               |                        | 2              |
| Air quality                | 7                                | 1                               | 5               |                        | 2              |
| UV radiation               | 1                                | 1                               | 7               | 2                      | 7              |
| General extremes           | 18                               | 6                               | 12              | 3                      | 7              |
| Floods                     | 28                               | 11                              | 15              | 5                      | 12             |
| Storms                     | 20                               | 3                               | 5               | 2                      | 12             |
| Fires                      | 12                               | 3                               | 6               | 5                      | 12             |
| Droughts                   | 23                               | 2                               | 7               | 7                      | 21             |
| Land shifts                | 18                               | 5                               | 6               | 3                      | 12             |
| Water safety and security  | 27                               | 11                              | 18              | 2                      | 12             |
| Food safety and security   | 27                               | 12                              | 13              | 4                      | 14             |
| Infectious disease         | 11                               | 2                               | 3               | 2                      | 5              |
| General health             | 7                                | 7                               | 6               | 2                      | 4              |
| Indeterminate              | 20                               | 21                              | 29              | 17                     | 8              |
| Total                      | 38                               | 27                              | 33              | 20                     | 22             |

* Indeterminate refers to groundwork actions described without explicit reference to any climate change vulnerability.
Table 3. Adaptation responses to health impacts of climate change. (Note: values indicate numbers of UNFCCC Annex I countries with actions reported in the given category.)

| Health vulnerability | Legislation | Departmental development and technology | Public awareness and outreach | Surveillance and monitoring | Evaluation | Financial support | Medical intervention | Other |
|----------------------|-------------|----------------------------------------|-------------------------------|----------------------------|------------|-------------------|---------------------|-------|
| Extreme heat         | 3           | 1                                      | 11                            | 2                          | 3          | 3                 | 1                   |       |
| Extreme cold         | 1           | 1                                      |                               |                            |            |                   |                     |       |
| Air quality          | 1           | 2                                      | 1                             | 1                          |            |                   |                     |       |
| UV radiation         | 5           | 5                                      | 4                             |                            | 1          |                   |                     |       |
| General extremes     | 6           | 6                                      | 2                             |                            | 1          |                   |                     |       |
| Floods               | 8           | 11                                     | 6                             |                            | 4          |                   |                     |       |
| Storms               | 4           | 4                                      | 2                             |                            | 1          |                   |                     |       |
| Fires                | 3           | 3                                      | 1                             |                            | 2          |                   |                     |       |
| Droughts             | 2           | 2                                      | 2                             |                            | 1          |                   |                     |       |
| Land shifts          | 3           | 3                                      | 2                             |                            | 1          |                   |                     |       |
| Water safety and security | 11   | 11                                     | 10                            |                            | 4          | 1                 | 1                   | 1     |
| Food safety and security | 2       | 12                                     | 6                             |                            | 3          | 1                 | 3                   |       |
| Infectious disease   | 1           | 3                                      | 3                             |                            | 1          |                   |                     |       |
| General health       | 12          | 15                                     | 4                             |                            | 9          | 1                 | 4                   | 3     |
| Indeterminate*       | 24          | 26                                     | 24                            |                            | 26         | 18                | 7                   | 7     |
| Total                | 24          | 26                                     | 24                            |                            | 26         | 18                | 7                   | 7     |

* Indeterminate refers to groundwork actions described without explicit reference to any climate change vulnerability.

recognition of health linkages, with 30% and 36% of actions recognizing a link with human health, respectively. Involvement of the health sector in adaptations like extreme heat warning systems (categorized as public awareness and outreach) accounts for higher levels of health linkage within these initiatives.

3.4. Reporting on groups is inconsistent across vulnerabilities and populations

Reporting on vulnerable groups focused most frequently on the elderly, individuals with chronic or pre-existing conditions, and children, with limited reference to other vulnerable groups (table 5). Concern for vulnerable populations was most frequently tied to extreme heat and air quality. 19 countries identified the elderly at least once in their NC5, 17 in connection with extreme heat. 17 countries demonstrated an awareness of particular vulnerability among individuals with chronic or pre-existing conditions across a range of health risks; this recognition was concentrated in extreme heat and declining air quality. Finally, 11 countries recognized risks to children from health vulnerabilities, most frequently from extreme heat. Recognition of the vulnerability of Indigenous groups was broader across health vulnerabilities, but restricted to Canada, New Zealand, the United States and Australia. There was limited discussion of other vulnerable groups such as women, disabled individuals, or people living in poverty.

Explanations about how the special needs of vulnerable groups are incorporated into adaptation actions were negligible. Only five countries discussed special accommodations for the elderly in public awareness and outreach programs, despite well recognized vulnerabilities of this group during extreme weather events. Reporting on adaptation actions related to vulnerable groups was predominantly restricted to public awareness and outreach activities.

3.5. Mainstreaming is prevalent among adaptation actions

When climate change as a general (i.e. non-health specific) issue is analyzed as a motivator for adaptation, we see that most adaptation initiatives result from mainstreaming a climate change focus into existing frameworks. The majority of groundwork actions extracted from the NC5 were initiated in direct response to climate change (71%, table 4). In contrast, only 39% of adaptation actions were new initiatives being implemented in direct response to climate change risks. Notably, 71% of infrastructure development and technology initiatives consisted of integrating a climate change lens into existing procedures, and 88% of legislative responses to climate change were the mainstreaming of climate change issues into existing laws and regulations. Conversely, 85% of Departmental Developments occurred primarily in response to climate change.

4. Discussion

Scholarship tracking and characterizing climate change adaptation actions is in its infancy, particularly in the health sector. Here we develop a methodology to systematically assess health adaptation at a national level that allows us to document interventions, assess adaptation needs, evaluate current policies, and prioritize areas where further support is required—key objectives of the WHO’s climate change workplan. The methodology allows for broad comparison among Annex I nations of the state of adaptation both directly
Table 4. Drivers of groundwork and adaptation action on climate change. (Note: values indicate numbers of UNFCCC Annex I countries with actions reported in the given category.)

| Type of action                                  | Explicit health linkage | Adaptations driven by assessment | Climate change as motivator |
|------------------------------------------------|------------------------|---------------------------------|----------------------------|
|                                                 | Explicit | Implicit | Total | Yes | No | Total | Mainstreamed/pre-existing | Primary | Total |
| Impact/vulnerability assessments                | 88       | 507      | 595   |     |    |       | 152                      | 443     | 595   |
| Assessments/adaptation research                 | 26       | 153      | 179   |     |    |       | 43                       | 136     | 179   |
| Conceptual tools                                | 35       | 289      | 324   |     |    |       | 139                      | 185     | 324   |
| Stakeholder networking                          | 13       | 55       | 68    |     |    |       | 8                        | 60      | 68    |
| Recommendation                                  | 45       | 323      | 368   |     |    |       | 102                      | 266     | 368   |
| Legislation                                     | 5        | 59       | 64    | 4   | 60 | 64    | 56                       | 8       | 64    |
| Departmental development                        | 4        | 50       | 54    | 54  |    | 54    | 8                        | 46      | 54    |
| Infrastructure development and technology       | 1        | 111      | 112   | 5   | 107| 112   | 79                       | 33      | 112   |
| Public awareness/outreach                       | 24       | 57       | 81    | 3   | 78 | 81    | 42                       | 39      | 81    |
| Surveillance and monitoring                     | 6        | 29       | 35    | 1   | 34 | 35    | 31                       | 4       | 35    |
| Evaluation                                      | 5        | 9        | 14    | 14  |    | 14    | 5                        | 9       | 14    |
| Financial support                               | 1        | 14       | 15    | 15  |    | 15    | 10                       | 5       | 15    |
| Medical interventions                           | 2        | 2        | 2     | 2   |    | 2     | 2                        | 2       | 2     |
| Other (specify)                                 | 1        | 1        | 1     | 1   |    | 1     | 1                        | 1       | 1     |
| Total                                           | 255      | 1657     | 1912  | 13  | 365| 378   | 675                      | 1237    | 1912  |

within the health sector, and in other sectors that have an impact on population health. Herein, the NCs—as official reports submitted by national governments to the UNFCCC—are particularly relevant, summarizing in a standardized format issues significant to governments, and demonstrating actions and policies that are considered representative of approaches to adaptation. This data source does not allow us to create an inventory of every adaptation initiative being undertaken among developed countries (indeed such a task would be impossible), but the systematic comparative methodology can be used to identify national policy priorities and characterize the role of the public health sector in climate change adaptation.

Across health vulnerabilities, countries reported far more impact and vulnerability assessments than adaptation actions. This is consistent with the experience of adaptation outside the health sector [20, 21]. In spite of the focus on describing national assessments of vulnerability and adaptive capacity, the link between research and adaptation outputs is vague. Only 13 adaptations explicitly cited an assessment as motivation for acting. There is need for further examination of how research is influencing or linking to the policy process; as scholarship in related field indicates, more and/or improved research does not necessarily translate into policy intervention [23–25].

National responses to climate change both at the groundwork and adaptation levels focus on select health vulnerabilities. Herein, we hypothesize that recent experiences with extreme events are reinforcing perceptions that certain vulnerabilities are more critical than others [21]. For instance, countries especially affected by the 2003 European heat wave—France, Netherlands, Switzerland, Italy, United Kingdom and Spain—highlighted the increased awareness of extreme temperature risks provoked by the event, and cited the experience as a direct motivator for action. Extreme events of this nature increase the saliency of climatic risks to the public and policy makers, and challenge the assumption that human systems are insulated from nature [26], providing an ‘availability heuristic’ [27] that the climate is changing and adaptation is needed. This is particularly important for slow-onset, ‘creeping hazards’ like climate change. Furthermore, policymakers may pay special attention to adverse impacts on sectors considered vital to the economy or politically sensitive. Irrespective of the reason for these differences, this analysis highlights clear gaps in national response.

Integration of vulnerable groups into adaptation initiatives remains underdeveloped and uneven across Annex I parties. Inclusion of vulnerable groups in policy guidelines and adaptation design is critical to reaching all population segments: UNFCCC reporting indicates that some countries are more widely incorporating vulnerable populations into planning and action than others. The elderly, children, and individuals with pre-existing or chronic diseases are the most frequently discussed vulnerable groups, but are still reported on by fewer than half of Annex I countries. Women and people living in poverty, while widely discussed in the literature on climate change vulnerability [13, 16, 28], are rarely considered in the NCs. Over one quarter of the sample (11 countries) failed to report on a single vulnerable group. These results raise questions about how much priority is being given to vulnerable groups in adaptation planning and implementation. While we cannot infer that vulnerable groups are not being integrated into adaptation, we can question whether an absence of national leadership on prioritizing these groups is allowing sufficient adaptation to occur.
**Table 5.** Recognition of increased health risks to vulnerable groups. (Note: values indicate numbers of UNFCCC Annex I countries with actions reported in the given category.)

| Vulnerable groups | Elderly | Children | Disabled persons | Indigenous | Chronic/pre-existing condition | Nationality | Race/ethnicity | Language | Sex/gender | Social disability | Social position | Other | None |
|-------------------|---------|----------|------------------|------------|--------------------------------|-------------|----------------|----------|------------|---------------------|----------------|-------|------|
| Extreme heat      | 17      | 6        | 1                | 11         |                                | 1           | 2              | 8        |            |                     | 1              | 2     | 3    |
| Extreme cold      | 1       |          |                  |            |                                |             |                |          |            |                     |                | 4     |      |
| Air quality       | 5       | 2        | 1                | 8          |                                | 1           |                |          |            |                     |                | 1     | 18   |
| UV radiation      |          |          |                  |            |                                |             |                |          |            |                     |                |       | 8    |
| General extremes  | 2       | 2        | 2                | 5          |                                | 1           |                |          |            |                     |                | 1     | 32   |
| Floods            | 1       |          |                  |            |                                |             |                |          |            |                     |                |       |      |
| Storms            | 1       |          |                  |            |                                |             |                |          |            |                     |                |       |      |
| Fires             | 1       | 1        |                  |            |                                |             |                |          |            |                     |                |       |      |
| Droughts          |          |          |                  |            |                                |             |                |          |            |                     |                | 2     | 35   |
| Land shifts       | 1       |          |                  |            |                                |             |                |          |            |                     |                | 29    |      |
| Water safety and security | 1 | 1 | 1 | 2 | 2 | 1 | | | | | | | | | |
| Food safety and security | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | | | | | | | | |
| Infectious disease | 1       |          |                  |            |                                |             |                |          |            |                     |                |       |      |
| General health    | 2       | 2        | 2                |            |                                | 1           |                |          |            |                     |                | 3     | 22   |
| Indeterminate     | 1       | 2        |                  |            |                                | 1           |                |          |            |                     |                | 1     | 32   |
| Total             | 19      | 1        | 2                | 4          | 17                             | 1           | 1              | 1        | 1          |                     |                | 9     | 5    |

*Indeterminate refers to groundwork actions described without explicit reference to any climate change vulnerability.*
A more detailed study of adaptation initiatives occurring at all governance levels would be necessary to determine the full extent to which particular groups are being included in the adaptation process.

Those adaptations that are occurring are often part of other policy initiatives not specifically targeting climate change. This is consistent with studies on other sectors, which indicate that adaptation rarely occurs in response to climate change alone [20, 21]. The benefits of such mainstreaming are widely acknowledged, allowing climate change to be integrated into ongoing policy priorities and focus to be directed to overall health protection [17, 29]. Notwithstanding, given the risks posed by climate change and climate stationarity often assumed in existing health policy and programming, specific climate change interventions are required to prepare and effectively respond to projections of future change. In the future, attention should be paid to identifying which adaptations are more effectively mainstreamed, and which adaptations are more effectively implemented separately.

The results of this study have several implications for actors in the health sector considering the impacts of climate change on health. First, there is a need to move beyond groundwork actions to actual adaptations that build on assessments and prepare communities and regions for a changing climate. Assessments, adaptation research, conceptual tools, stakeholder involvement, and policy recommendations are critical first steps of adaptation and reflect the relatively recent recognition of health risks association with climate change, but the imbalance in reporting between groundwork and adaptation initiatives suggests that health-relevant action is still in its infancy. In particular, the failure of countries to report the completion of policy evaluations suggests that health adaptations are still maturing, and that the health sector needs to push further on implementing adaptation. More information in national reporting on how climate change considerations are being integrated into existing health institutions and policy guidelines would provide a more comprehensive picture of the status of adaptation. For example, descriptions of where and how climate change risks assessments are being integrated into existing heat wave warning systems and emergency medical response standards would provide a more nuanced understanding of action being taken to adapt to risks of extreme heat. The absence of wider reporting such as this in the NC5 raises concerns about the likelihood of effective action given the speed of climate change, limited window of opportunity for action, and time requirements to progress from problem identification to actual intervention [30]. Further analysis of the next NC will be necessary to determine how far health adaptation has progressed in the time since the NC5 was submitted; time lapse between reporting periods means that health adaptation may have evolved since the NC5 was submitted.

Second, policymakers need to engage all segments of the government and facilitate broad inter-sectoral cooperation on adaptation issues. The NC5 demonstrates that many adaptation actions are being considered without explicit recognition of their impact on human health, indicating that national leadership from the health sector is not emerging in the planning and implementation of adaptation. This finding is consistent with studies that have argued that the health sector has been slow to become engaged in environmental issues [4]. Given the nature of the risks associated with a changing climate, however, almost all sectors will be responsible for adaptations that will impact human health. In engaging stakeholders from multiple sectors, the health implications of adaptation will be more widely understood and appreciated, improving the effectiveness of adaptation initiatives on health.

Third, evaluations on the effectiveness of adaptation initiatives need to be conducted more widely in order to improve existing adaptations and to assess the relative advantages of different adaptation approaches. There is no evidence in the NC5 that evaluations are being undertaken, which indicates that a critical step in the adaptation process is missing. Reporting guidelines in subsequent NCs should be cognizant of the potential for including evaluations as a component of adaptation reporting, as it allows for better assessment and accountability of the effectiveness of adaptation initiatives, and also demonstrates how far countries are progressing in the implementation process. Evaluations should also examine the relative merits of mainstreaming adaptation compared to implementing new climate change initiatives.

Finally, an awareness of the special needs of vulnerable groups in adaptation planning is necessary to ensure that adaptation efforts are effective for all segments of the population. It is groups vulnerable to negative health outcomes today who are most likely to be affected by future climate change. Analyses of how climate change will impact the health of the elderly, children, individuals with pre-existing or chronic conditions, people living in poverty, women, and indigenous groups are well developed within the scientific literature. These results, however, indicate that national leadership on incorporation of vulnerable groups is lagging, which brings into question the effectiveness of current adaptation efforts, as well as broader issues of social justice considerations in adaptation policy. A dialogue on vulnerable groups needs to be developed within UNFCCC reporting mechanisms in such a way that countries are encouraged to reflect on the participation of vulnerable populations in the adaptation process and can be held accountable for the development and implementation of effective adaptations.

A strong case for the need to adapt has been established in the scientific literature, but our understanding of how much adaptation is actually occurring is limited. The methodological framework developed in this study can be expanded in future analyses to include all UN countries (e.g., examination of NAPAs), or can be replicated to analyze adaptation progress in the upcoming Sixth National Communications of Annex I parties. This systematic approach allows for comparative analyses that can identify leaders and laggards on adaptation, or piece together an overall picture of the current state of adaptation action. In light of the growing focus on adaptation within the response to the health risks of climate change, this kind of comparative framework will be centrally important for future studies.
Acknowledgments

This project and the researchers contributing to it were funded by a knowledge synthesis grant from the Canadian Institutes of Health Research (CIHR: KRS-103279) and the Canadian Foundation for Cliniastic and Atmospheric Science (CFCAS: GR-KS-005). The methodological framework was developed and data analyzed independently of the funding agencies. The authors extend special thanks to Dr Peter Berry, Dr Tom Kosatsky and Jim Henderson for input during the development stages of this project. We are also grateful for support from Adam Mahon, Alex Ginsburg, Catherine Ianovskaia, Kyle Chauvin and Will Vanderbilt during the data collection and analysis process.

References

[1] Costello A et al 2009 Managing the health effects of climate change Lancet 373 1693–733
[2] New M, Liverman D, Schroder H and Anderson K 2011 Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications introduction Phil. Trans. A 369 6–19
[3] WHO 2008 Protecting Health from Climate Change (Geneva: World Health Organization)
[4] McMichael A J, Neira M, Bertollini R, Campbell-Lendrum D and Hales S 2009 Climate change: a time of need and opportunity for the health sector Lancet 374 2123–5
[5] Hajat S, O’Connor M and Kosatsky T 2010 Health effects of hot weather: from awareness of risk factors to effective health protection Lancet 375 856–63
[6] Kinney P L 2008 Climate change, air quality, and human health Am. J. Prev. Med. 35 459–67
[7] Semenza J C and Menne B 2009 Climate change and infectious diseases in Europe Lancet Infect. Dis. 9 365–75
[8] Patz J A, Campbell-Lendrum D, Holloway T and Foley J A 2005 Impact of regional climate change on human health Nature 438 310–7
[9] Schmidhuber J and Tubiello F N 2007 Global food security under climate change Proc. Natl Acad. Sci. USA 104 19703–8
[10] Campbell-Lendrum D, Bertollini R, Neira M, Ebi K and McMichael A 2009 Health and climate change: a roadmap for applied research Lancet 373 1663–5
[11] WHO 2009 Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks (Geneva: World Health Organization)
[12] Robine J M, Cheung S L K, Le Roy S, Van Oyen H, Griffiths C, Michel J P and Herrmann F R 2008 Death toll exceeded 70,000 in Europe during the summer of 2003 C. R. Biol. 331 171–8
[13] Duncan K 2007 Global climate change, air pollution, and women’s health Manag. Nat. Resour. Sustain. Dev. Ecol. Hazards 99 633–43
[14] Ford J D, Berrang-Ford L, King M and Furgal C 2010 Vulnerability of aboriginal health systems in Canada to climate change Glob. Environ. Change 20 668–80
[15] Beggs P J 2010 Adaptation to impacts of climate change on aeroallergens and allergic respiratory diseases Int. J. Environ. Res. Public Health 7 3006–21
[16] Ramin B and Svoboda T 2009 Health of the homeless and climate change J. Urban Health 86 654–64
[17] Ebi K L 2009 Managing the changing health risks of climate change Curr. Opin. Environ. Sustain. 1 107–10
[18] Chan M 2008 World Health Day: Message from WHO Director-General (Geneva: World Health Organization)
[19] Neira M, Bertollini R, Campbell-Lendrum D and Heymann D L 2008 The year 2008 a breakthrough year for health protection from climate change? Am. J. Prev. Med. 35 424–5
[20] Berrang-Ford L, Ford J D and Paterson J 2011 Are we adapting to climate change? Glob. Environ. Change 21 25–33
[21] Ford J D, Berrang-Ford L and Paterson J 2011 A systematic review of observed climate change adaptation in developed nations Clim. Change Lett. 106 327–336
[22] IPCC 2007 IPCC Fourth Assessment Report (AR4). Climate Change 2007: Contributions of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge: Cambridge University Press)
[23] Heymann J 2000 Social Epidemiology ed L F Berkman and I Kawachi (Oxford: Oxford University Press) pp 368–82
[24] Adger W N and Barnett J 2009 Four reasons for concern about adaptation to climate change Environ. Plan. A 41 2800–5
[25] White G F, Kates M R W and Burton I 2001 Knowing better and losing even more: the use of knowledge in hazards management Glob. Environ. Change B 3 81–92
[26] Lorenzoni I and Hulme M 2009 Believing is seeing: laypeople’s views of future socio-economic and climate change in England and in Italy Public Underst. Sci. 18 383–400
[27] Tversky A and Kahneman D 1974 Judgement under uncertainty—heuristics and biases Science 185 1124–31
[28] Beaumier M and Ford J 2010 Food insecurity among Inuit females exacerbated by socio-economic stresses and climate change Can. J. Public Health 101 196–201
[29] Dovers S 2009 Normalizing adaptation Glob. Environ. Change 19 4–6
[30] Ford J and Berrang-Ford L 2011 Introduction Climate Change Adaptation in Developed Nations: From Theory to Practice ed J Ford and L. Berrang-Ford (Berlin: Springer) pp 3–20