



*Research article*

## **The roles of governments and other actors in adaptation to climate change and variability: The examples of agriculture and coastal communities**

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**Abstract:** There is little question now about the reality of climate change and the importance of adaptation of human activities in reducing the negative impacts of climate change and variability (CCV) as well as the reduction of Greenhouse Gas Emissions in mitigating this unprecedented phenomenon. This article focuses on adaptation and the adaptive capacity of actors (decision-takers) of all sorts to adopt appropriate strategies and increase their adaptive capacity to cope with CCV by focusing on two types of human activity—agriculture and agricultural territories and coastal communities, both of which have very important roles to play in human society. Given the recent high profile given to the outcomes of COP21 and particularly the potential transfer of significant funding from developed to developing countries to support their battle against CCV, the emphasis has shifted again to the role of governments in this battle. We argue that governments have important roles to play both in developed and developing countries, but supporting funding of initiatives and for developing pertinent action plans is probably the least of our worries! Funding can be important but alone does not solve the challenges, it is what is accomplished with funding that is all important,

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and this requires the development of effective and pertinent adaptive capacities on the part of the different actors involved in what becomes a co-construction process. We argue that the roles of governments and other actors (collective as well as individual citizens and the activities that they are involved in) need to be better understood in order for this to happen. This is illustrated by research of different types on agriculture and coastal communities.

**Keywords:** Adaptive capacity; roles of governments and other actors; holistic planning; strategic development planning; co-construction of plans and initiatives

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## 1. Introduction

Globally, the intensity and frequency of extreme climatic events, such as heat waves, droughts, storms and floods, and sea level rise [1] are increasingly recognized as related to climate change and variability (CCV) [2-4]. Since the 1960s, worldwide losses due to natural disasters have roughly doubled [5]. Recent examples of extreme climatic events include the widespread flooding episode that affected the countries of Germany, Austria and the Czech Republic in 2002, the heat wave that caused thousands of deaths across Europe in 2003, Hurricane Katrina—the costliest storm of all time in 2005, the forest fires that caused damage throughout the Mediterranean region in 2007 [5], and the flood of Lake Champlain and the Richelieu River drainage basin (LCR) in 2011 which was the worst and longest lived disaster in Québec [6,7]. Similarly, the storm known as Xynthia on the 27th and 28th February 2010, which caused 47 deaths [8], was described as a catastrophe both in terms of human and environmental consequences, including 577 houses that were classified in a ‘black zone’ and which were demolished. These climatic disasters can however create positive long-term opportunities such as creating institutional structures for disaster management and improvement in social networking, while at the same time having a detrimental cascading effect on biodiversity, ecosystems, water resources, and human livelihoods [2]. All in all, CCV invariably affects human-environment interactions or socio-ecological systems (SES) and their processes [2,9,10], and of course all forms of human activity.

It is important to emphasize, however, that all territories (municipalities, cities, regions, countries...) have to cope with different circumstances, challenges and opportunities. For instance, it has been reported that the degree to which climate-related needs or constraints pertinent to water resources is regionally specific [12]. This has important implications for policies, plans and strategies for coping with CCV since it means that the ‘one size fits all’ approach is not likely overall to have constructive results [13]. In the European Union, the importance of climate change still encounters difficulties in becoming integrated into planning policies, and there have been cases where populations have been so strongly opposed to integrating this problematic into planning frameworks that some local authorities have conceded in the face of such opposition.

To deal with CCV, mitigation (that involves creating systems to eradicate the effects of CCV in terms of Greenhouse Gas emissions) is certainly important, but so is adaptation which involves enabling people and communities to adjust or adapt to the ongoing effects of CCV as well as to new or increased effects in the future [14-16,5,17-21]. Adaptation continues to receive increased attention from more and more governments, international negotiations, and the research and policy communities [22-24,5,4,12]. When it comes to adaptation, it is rather climate variability that tends to

interest us more than just average increases in temperatures [23-26] cited in [27,5]. Moreover, climatic as well as non-climatic factors (such as political, social, cultural and economic conditions) should be taken into consideration in understanding and encouraging the process of adaptation to CCV [27-30,5]. As a result, planned adaptation necessitates an integrated assessment of both climatic and non-climatic scenarios and this must take account of complex socio-ecological interactions. When this does not occur - which happens all too frequently, this is one reason why government actions, including planning, can have unintended consequences<sup>1</sup> [31].

In the following Section 2, an original conceptual framework based upon the research undertaken by the authors of this article is presented to help understand the process of adaptation to CCV and the key dimensions of this process. This framework can be used to analyze the dimensions of adaptation to CCV for any type of human activity and territory. Clearly, the results will reflect the particular characteristics of the territory and activities under consideration. Section 3 focuses on a particular approach for development planning that can include coping with CCV, reinforcing adaptation capacity and building community resilience in relation to CCV. In particular, a holistic approach is emphasized in which the strategic orientations developed are chosen in a process of strategic development planning for and by the citizens because they constitute critical orientations that should be followed to reach the community's or territory's vision or global objectives. Such a holistic approach helps ensure that none of the strategic orientations chosen can be left aside and considered marginal. Such is the case of a strategic orientation dealing with adaptation to CCV or with CCV in general. The importance of a strategic orientation dealing with adaptation to CCV or CCV in general is that such orientations are known as transversal strategic orientations (see Section 3) which means they have implications for many of the other strategic orientations that a community or territory (or government organization) may have identified. In sections 4 and 5, the

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<sup>1</sup> This article is based principally upon the research undertaken by the lead author and the co-authors. Christopher Bryant has been involved in research into the adaptation of agriculture to climate change and variability for some 26 years, principally in Quebec and also to a lesser extent in Ontario while director of the Laboratory of Sustainable Development and Territorial Dynamics at the University of Montreal. Apart from the publication of many articles and presenting many communications on the subject, together with one of the co-authors of this article, Kénel Delusca, he has also edited a book on Agricultural Adaptation to Climate Change [11] involving international comparisons between developed and developing countries. In addition, two other research domains characterize Bryant's profile; 1. approximately 50 years of research on agriculture in periurban areas around major urban and metropolitan centers, in France, Ontario and Quebec as well as other countries with a focus on the transformation of different agricultures when confronted by multiple stressors and on the decision-making processes of farmers in different socio-economic systems of agricultural production; and 2. approximately 30 years of research and practical intervention in local and regional community development, including a major focus on strategic development planning for and by the community – this includes 5 years of research into coastal communities and their adaptation to climate change and variability. These two additional domains of research have become integrated into his research and practical interventions in climate change adaptation and are used later in this article. The other co-authors are either former graduate students of Bryant (Antonia Bousbaine, Chérine Akkari, Oumarou Daouda, Kénel Delusca, Charles Drouin-Lavigne) or former post-doctoral fellows (Kénel Delusca, Terence É. Épule). Their research has largely been focused on agriculture, but also on coastal communities and the environment. Their research has for the most part been linked to the research projects managed by Bryant, but also to their own research and experience in other countries (e.g. Belgium (Bousbaine), Cameroun (Épule) and Haiti (Délusca) (see references cited in Sections 4 and 5)).

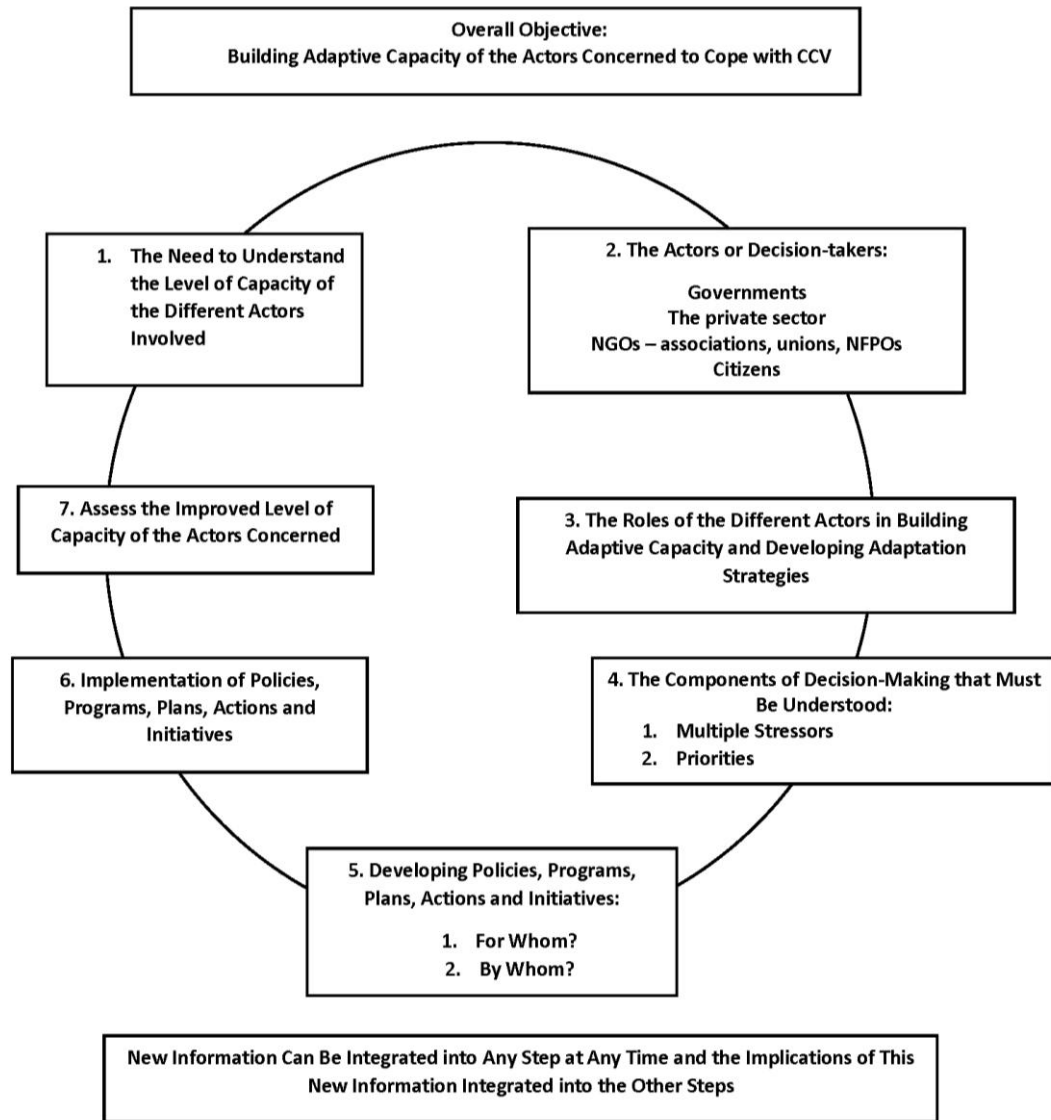
framework of Section 2 is used to organize the discussion of adapting to CCV for agriculture and agricultural territories (Section 4) and coastal communities (Section 5). The most significant challenges facing developing appropriate adaptation strategies to cope with CCV are presented in Section 6. Finally, in Section 7, the principal conclusions are presented regarding how to cope with these challenges, including the roles of governments at all levels.

## 2. A conceptual framework for understanding how to deal with CCV

The conceptual framework in Figure 1 is applicable to both agriculture and coastal communities (as well to other domains such as tourism development and reducing vulnerability to climate change and variability in large cities) and is developed in more detail for agriculture and coastal communities in Sections 4 and 5 respectively. This conceptual framework represents the most significant dimensions identified in the research of the lead author and co-authors. These dimensions have generally been accepted as dimensions that need to be understood by many of the actors who have participated in these research projects through focus groups and various forums. These events have involved a variety of actors including farmers, farmer associations and local farmer clubs, representatives of the ministries of agriculture, environment and natural resources, mayors and municipal and regional councilors, business owners, watershed management organization personnel, and citizens.

The focus or Overall Objective of the conceptual framework is on **building adaptive capacity and adaptation strategies to cope with CCV**. This involves potentially a broad range of actors, including citizens, since the consequences of not adapting or of adapting can be substantial for those who are not directly involved in developing and adopting adaptation strategies; this is why it is possible to speak of the co-construction of the plans, strategies and actions to deal with CCV even if (for the moment) real co-construction processes are relatively limited in number. The various levels of government have often been identified as being important actors in building capacity for developing appropriate adaptation strategies, but this also raises important questions because many governments - less so for local and regional governments - do not have a profound understanding of what drives other actors and do not often have a presence *‘on the ground’* which would bring them into regular contact with nongovernmental actors [13]. Some government bodies can also face economic dilemma regarding what they are prioritizing or should prioritize when they have to deal with small budgets and when they cannot afford the proper preparation of the necessary infrastructure and/or do not have the necessary human resources to face such challenges. In addition, many governments, it can be argued, also need to build their own capacity to adapt to CCV in such a way as to avoid as much as possible the unintended consequences of government-inspired policies, plans, strategies and initiatives [31,32]. Thus, there is a need to understand the **capacity level** (box 1, Figure 1) of all **actors** involved (box 2, Figure 1).

The potential **actors or decision-takers** can be classed into 4 categories for our current purpose (box 2, Figure 1): i. **Governments at different levels** from central governments to local municipalities including towns, cities and regional municipalities; ii. the **private sector** with its business owners and managers, including farmers; iii. **Non-governmental organizations (NGO’s), associations, unions and Not-for-Profit-Organizations (NFPO’s) or social enterprises**; and, of course, iv. **individual citizens**. All of these actors take decisions including potentially decisions regarding how to cope with CCV.



**Figure 1. Conceptual framework of building adaptive capacity and adaptation strategies to cope with climate change and variability.**

Each actor can take decisions in relation to CCV about the appropriate **roles** each can adopt and/or to support particular adaptation strategies pertinent to the human activities under consideration (box 3, Figure 1). The types of roles that different actors can undertake are: i) **proactive roles** – taking initiatives, developing programs and policies, and adopting a particular adaptation strategy; ii) **support roles** – financing, advisory roles, providing pertinent information to other actors; and iii) **involvement with other actors through co-construction** of policies, programs and the development of other interventions, in other words a combination of proactive and support roles.

Then (box 4, Figure 1), to be effective the involvement of actors such as different levels of government when they take on support roles or become involved in co-construction processes requires that they fully understand **two interrelated components** of the decision takers they are working with and trying to influence by building their adaptive capacity and co-constructing appropriate adaptation strategies: i) The **multiple stressors** that each decision-maker or actor must

come to terms with, e.g., for a farmer within a few years of retirement whether or not he/she has children willing to take over the farm, for a business whether the business is already substantially indebted, or whether for a municipality there is a major concern about maintaining the level of employment in the municipality in the private sector; and ii) inevitably many of these multiple stressors may be seen by the actors involved as being more important in the short to medium terms than dealing with CCV, and this leads to **different priorities** that each actor or decision-maker has to determine and work with. Differences in priorities can be seen between actors in the same municipality or territory and frequently more often between actors in different municipalities or territories. Above all, it is important to emphasize that each actor - particularly political actors - puts forward his or her own interests, for instance, for politicians their preoccupation of becoming re-elected even if it has negative consequences for dealing with climate change. Once again, this suggests strongly that government cannot simply develop programs and other types of interventions on the 'one size fits all' basis.

The framework also identifies the range of **actions or initiatives** that different actors can become involved in (box 5, Figure 1). These can range from developing pertinent policies and programs by senior governments (always preferably through co-construction processes), to supporting and developing infrastructure development (such as protective infrastructure against flooding both along rivers and in coastal communities), to initiating strategic development planning to provide a holistic framework in which CCV can be dealt with and into which coping with CCV and its effects are integrated (see Section 3). We note that at the levels of local and regional municipalities or counties, the initiatives even for setting up a process of strategic development planning for and by the community does not have to be initiated or managed by the local or regional government (e.g., [33]). Similarly, in Wallonia where citizens have become involved in the management of risks [34] and the causes of these risks, some citizens have become involved in the decisions that need to be taken.

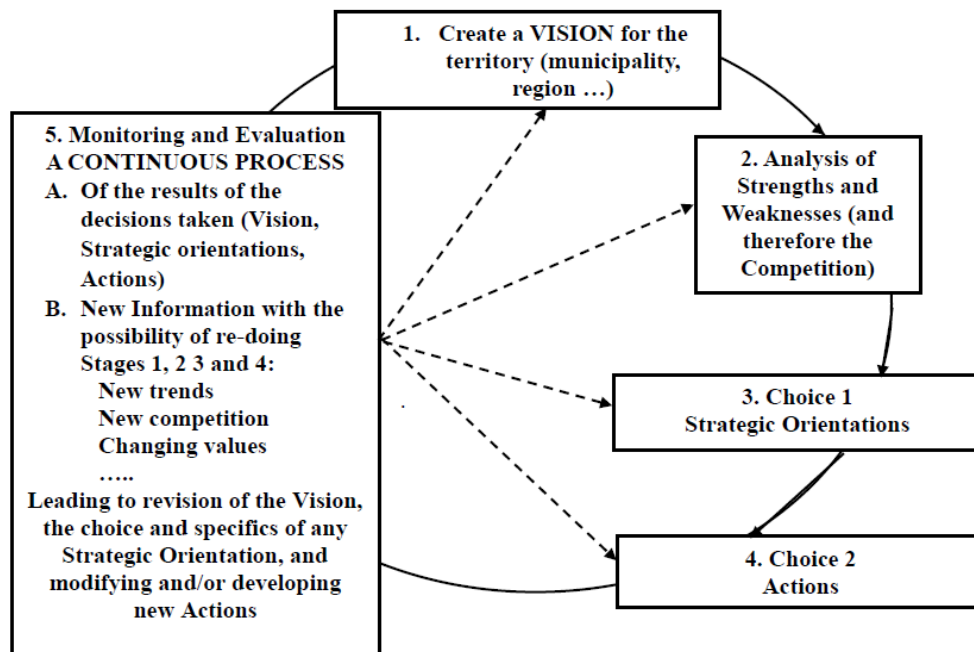
Of course, as policies, programs, plans, actions and initiatives are put in place, one of the key results that needs to be analyzed is whether there has been an improvement in the level of capacity of the actors concerned. If such is not the case, the logical response is to ask why, and whether changes need to be made such as reviewing the actors who have been involved, their roles, whether multiple stressors and the priorities of different actors have been effectively taken into account, and whether the policies, programs, plans, actions and initiatives have been conceived appropriately including how they have been implemented.

### **3. Holistic frameworks for planning development and including adaptation to CCV**

There are several types of planning that can help manage and set in place different development processes as well as attempt to reduce the negative consequences associated with certain types of development as well as those associated with CCV. Land use planning is one of the major planning tools in many countries, usually implemented at local and regional levels but in the context of legislative frameworks or strong recommendations or policies developed by senior governments (including provincial governments in Canada and States in the US). However, land use planning alone cannot deal with many of the issues that arise from CCV such as introducing new strategies to better cope with CCV or developing greater community solidarity and resilience to cope with CCV. Strategic development planning for and by the community (in effect all actors potentially, including citizens) has a much greater potential to integrate CCV into a holistic framework. This is because

this type of strategic development planning is not based on the relatively rigid type of structure as is the case with land use planning; it is therefore entirely possible – as long as the actors involved desire it – to deal with such issues as community solidarity and community resilience, improved communication with all actors (including citizens of course) and environmental management. Furthermore, such strategic development planning can integrate new information and events at any time since this type of planning is an **ongoing** process, and at the same time it is one of the best ways of integrating a community's citizens into a reflection process focused on long term development while also being able to deal with short and medium term events. We are talking not just about strategic planning driven by elected officials, professionals and consultants, but strategic development planning for and by the community. We focus on the community or territory level simply because of the need to take account of the frequently substantial differences between communities and territories.

Figure 2 presents the general steps involved in such a strategic development planning process. The introduction of the type of strategic planning for development that is our focus necessarily involves a wide range of actors and all segments of legitimate interest in the population who want to contribute to how the territory, municipality or region should evolve (based on input from all the actors involved – thus it is also a process of co-construction) [29,35]). Five main steps are represented; it is important to emphasize that these steps are nonlinear and that when different circumstances arise that had not been taken account of earlier, parts of the process will inevitably need revisiting (as indicated in box 5, Figure 2).



Source: Developed from [29] and [35]

**Figure 2. Strategic development planning for and by the community or territory as a holistic planning framework.**

The first step (box 1, Figure 2) usually involves creating a **Vision** for the territory or municipality.

Constructing a Vision represents a statement of what the participants (frequently through discussions in small discussion groups) would like to see in their territory or municipality in the next, say, 10, 15 or 20 years. This also involves identifying the most significant challenges and potential opportunities faced by the territory or municipality. The next step (box 2, Figure 2) involves undertaking an **analysis** of the recent challenges, transformations and current opportunities to ensure that the Vision is reasonable even at this early stage; as a result of this it may be necessary to revisit the Vision (hence a nonlinear step in the process).

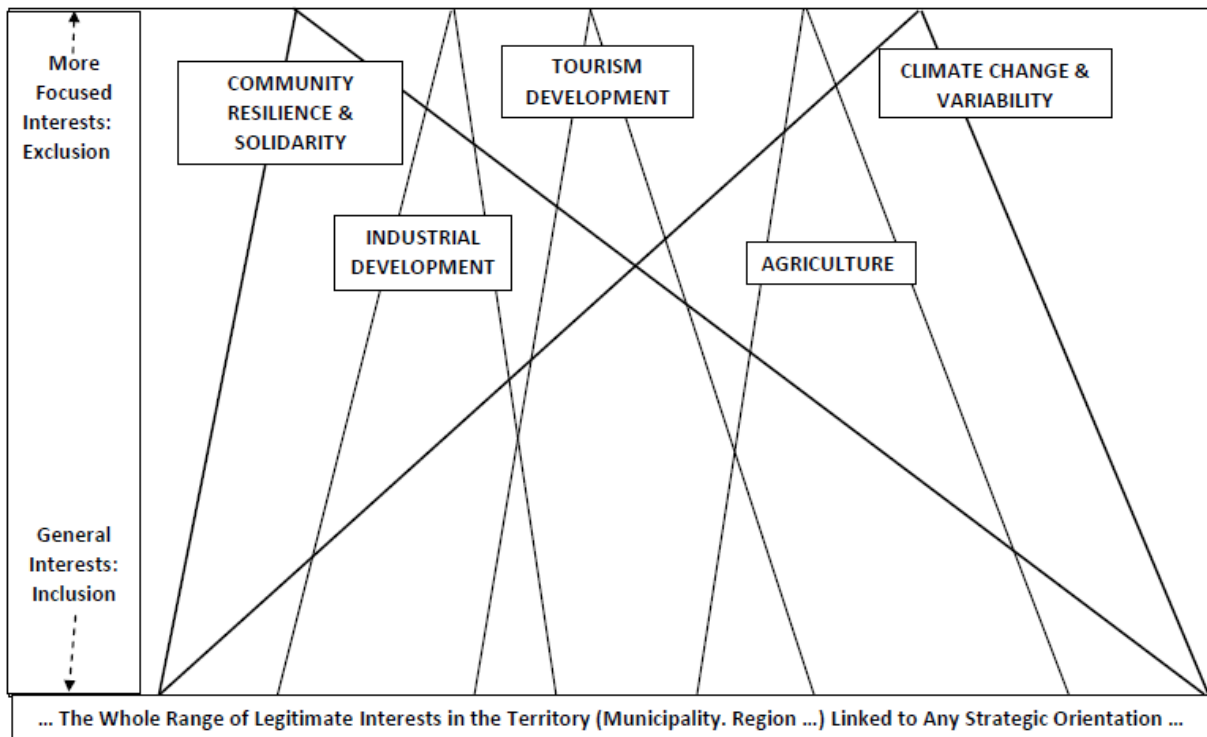
The next step is to discuss and identify the **Strategic Orientations** (box 3, Choice 1 on Figure 2) that represent the principal domains in which action is considered necessary to move towards the Vision. These Strategic Orientations can be either Geographic (e.g., a downtown area, a flood plain...), Sectoral (e.g., agriculture, tourism, the fishing industry...) or Transversal (i.e., domains that cut across other Orientations be they Geographic or Sectoral; examples are Climate change and variability, building community resilience, building community solidarity, and effective communication between government (local and regional) and the communities). All strategic orientations can be managed by a group of actors, including citizens (see for instance [33], although this also depends upon the cultural values at a given time in a particular community or territory. The strategic orientations chosen by the actors form the basis for the organization, planning, mobilization of actors and for identifying and engaging in **action** (box 4, Choice 2, Actions, Figure 2). It is important to re-emphasize that strategic development planning is NOT a linear process, and that any time, e.g., when something unexpected occurs or even when new values start to be developed, the process can be re-visited and new strategic orientations integrated into the process (see the dashed lines between step 5 with the other 4 steps in the process). Furthermore, new partners and partnerships can also be integrated into the overall planning process at any time including into a strategic orientation focused on climate change adaptation [36].

Figure 3 presents some examples of sectoral and transversal Strategic Orientations, which actually provide the framework for the organization of the strategic planning process, the detailed planning of actions and the mobilization of the actors (and citizens) who are the most interested in a given Strategic Orientation. In effect, each Strategic Orientation identified by the participants can go through the steps of setting up objectives (akin to the Vision but this time for a given Strategic Orientation), undertaking any necessary analyses and then identifying the actions deemed necessary to move forwards and of course revising any step if important new information is received. The horizontal axis on Figure 3 represents the whole range of legitimate interests in the community or territory that are to be taken into account. The vertical axis indicates the range of interests (and their actors) that can be observed at a given time for each strategic orientation. For instance, in the agricultural orientation, at the top we would expect to find farmers and their families. As we move down the axis, we would find farmer discussion groups or clubs, private companies selling inputs to farmers, ministry of agriculture representatives and further down, non-farm families who co-habit the same territories as the farmers and environmental groups or associations, all of whom have an interest in what happens to agriculture.

Figure 3 clearly shows how community resilience and solidarity, on the one hand, and climate change and variability on the other hand, have impacts and relationships with the Sectoral Strategic Orientations on this diagram (as well as with some or all of the Geographic Orientations identified in the process of reflection). Taking action in a given strategic orientation can yield results which need to be monitored and evaluated (box 5, Figure 2). The results of monitoring and evaluation need to be



shared across all strategic orientations. This sharing characteristically gives rise to a ‘\_hub’ committee or coordinating group, as in the case of Haliburton County [29,33].



Source: Developed from [29] and [35].

**Figure 3. Some examples of sectoral and transversal strategic orientations.**

At any time, earlier steps may need to be revised (e.g., new events occur, new ideas surface about an additional strategic orientation that becomes necessary to tackle, and so forth...) which simply reinforces the idea that a strategic development planning process is nonlinear in nature.

For the Climate Change and Variability strategic orientation, one might find at the top of the triangle actors and interests who consider themselves to be directly concerned by CCV, and then further down actors and interests who are simply concerned by what CCV might do to their community including school teachers and commercial business owners.

Figure 3 shows that as we move from the actors (at the top of the triangle) who are directly concerned by CCV because of what CCV can do to their businesses (e.g., farms) and families, the range of legitimate interests and actors implicated gets larger and almost automatically leads us to think about the co-construction of a plan and the actions to undertake. Of course, over time the range of legitimate interests and actors involved is likely to increase as people become more aware of the implications of CCV. A similar situation exists for building community solidarity and community resilience.

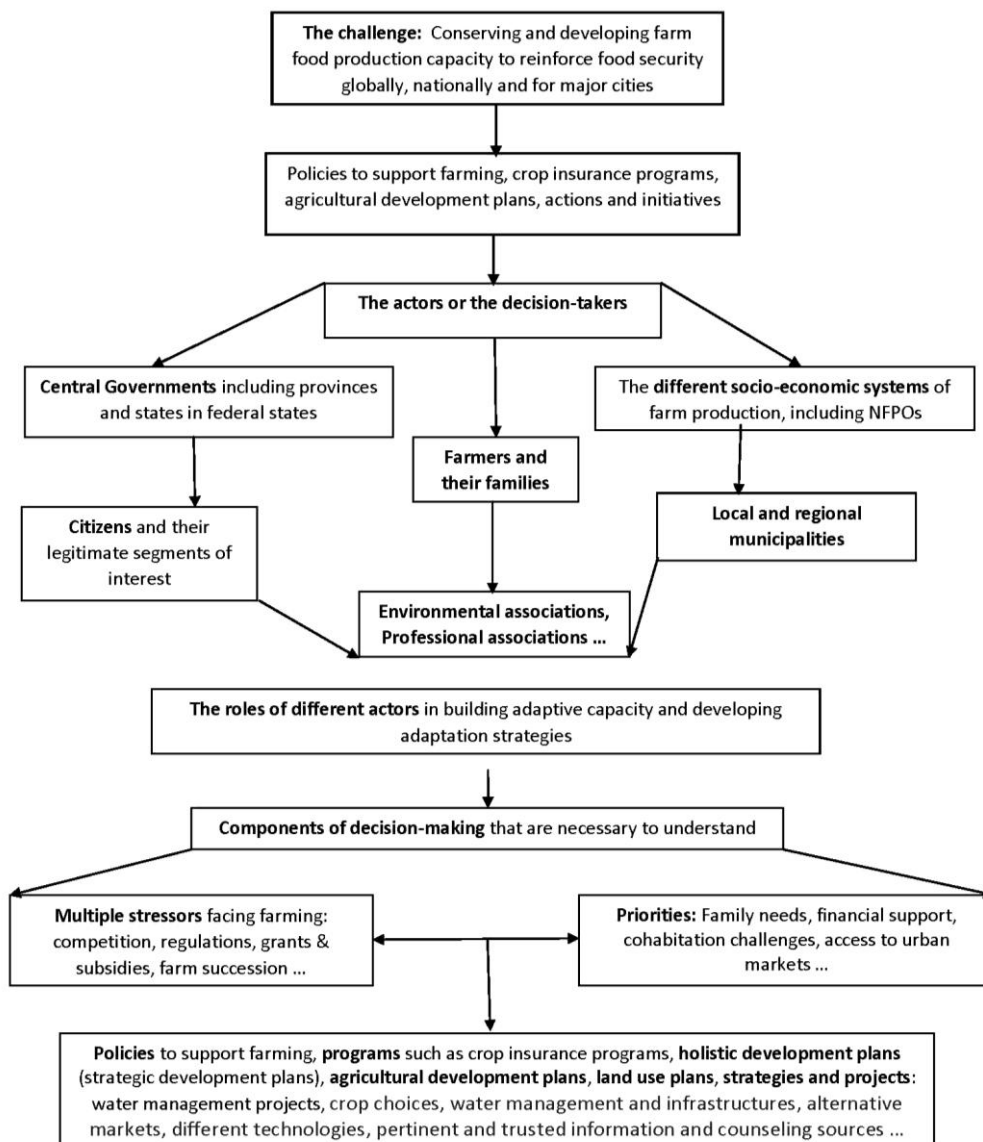
In Canada, one of the classic examples of successful strategic developing planning by and for the community has been Haliburton County in Eastern Ontario [33] [37], which over the years has seen its strategic development plan evolve to take into consideration other strategic orientations,

including that of more effective Communications between local governments and the population and businesses.

The holistic perspective of a successful strategic development planning process can help avoid the marginalization of certain challenges including dealing with CCV. In the next two sections we introduce and discuss the examples of Agricultural adaptation and the Adaptation of coastal communities to CCV.

#### 4. Agricultural adaptation

With agriculture, the challenges linked to CCV are to develop and conserve food production capacity (globally and at the level of major metropolitan regions both in developed and developing countries) (Figure 4). This challenge is also directly related to maintaining and improving food security... not only in terms of the quantity of food production but also in terms of the quality of food products related to the negative impacts that some types of food products can have on human health [38].



**Figure 4. Agriculture and agricultural territories: building adaptive capacity.**

Naturally the majority of initiatives and specific actions in relation to agriculture and CCV are specific to agriculture. They include policies to support farming, crop insurance programs to help farmers cope with unexpected negative impacts, for instance, of significant seasonal changes in climate conditions that affect agricultural production negatively, as well as many other more specific initiatives and actions. Since the late 1990s in the research conducted at the University of Montreal by the lead author, the research benefitted from a vast amount of data (25 to 30 years) on compensation claims in the context of crop insurance programs by farmers in the study regions in Quebec; these data were provided by the FADQ (Financière Agricole du Québec or the Financial Corporation of Quebec) [39,40]. These data and the temporal analyses which were undertaken for the study areas provided the turning point for the farmers involved in the discussion groups to completely appropriate the reality of CCV.

The actors or decision-makers implied in Agricultural adaptation to CCV include of course potentially governments at all scales (although not all are in fact involved by any means). They also include citizens and their various associations such as Environmental Associations and different Professional associations such as farm syndicates or unions and local and regional clubs of farmers such as the Clubs Conseils in Quebec.

In addition, from the farmer and farm family perspective, it is crucial to recognize the existence of different socioeconomic systems of food production, e.g., subsistence farming, family farm systems, capitalist agriculture, organic farming and sustainable farming (e.g., farms which adopt agro-ecological practices [41]). An understanding of these different socioeconomic systems of agricultural production (cf. [42]) provides one of the reasons why farmers' behavior can vary substantially between developed and developing countries and even between different territories in the same country [43] for the simple reason that the primary motivation for the farmers or peasant farmers can be so very different depending upon the socioeconomic system of farming they are involved in; this also means that their priorities can be very different. In relation to the marketing of food produce, some farmers (the large scale capitalist producers) are very much oriented to international and national markets, while many organic and sustainable agricultural farmers can be highly motivated to sell their produce directly to the consumer or groups of consumers (such as via the AMAP (Association pour le Maintien de l'Agriculture Paysanne (Association for Maintaining Small-Scale and Family Farming)) in France.

It is also very clear when reviewing farmer and farm family behavior that there are multiple stressors at the farm level depending upon individual and family circumstances, the socioeconomic system of agricultural production and the capacities of the decision-makers (farmers and their families, farm business managers and owners...). For instance, farm succession can be of tremendous importance for some farmers who are not likely to want to invest in new technology or ways of farming if there is little hope that any of their children are willing to take over the farm. This was evident in the research undertaken under the lead author's direction [39,40] during which an analysis of farmers' priorities in the Lac-St-Jean region in the northern part of Quebec's agricultural area showed that farmers there had a major concern and priority regarding farm succession, while in the South-West Montérégie region, the region with the best agricultural land resources in the province, farmers' priorities were more focused on what was happening to their competitors in other parts of Canada and the U.S.A..

It is also clear that the sources of trusted information and counseling can vary as well. Daouda attributed a central role to social processes in the diffusion of adaptation strategies such as the roles

of private companies, neighboring farmers and their own Clubs Conseils that group together small networks of farmers in the same territory [44].

There are many examples of adaptation strategies adopted by some farmers that are pertinent in coping with CCV and in which governments have little or no involvement. One of the obvious strategies that reflects this is to change the choice of crops or cultivars so that they are more appropriate to the changing climatic conditions; this was often one of the strategies that farmers were looking at in the research undertaken by the research group based at the University of Montreal (e.g., [39,40]).

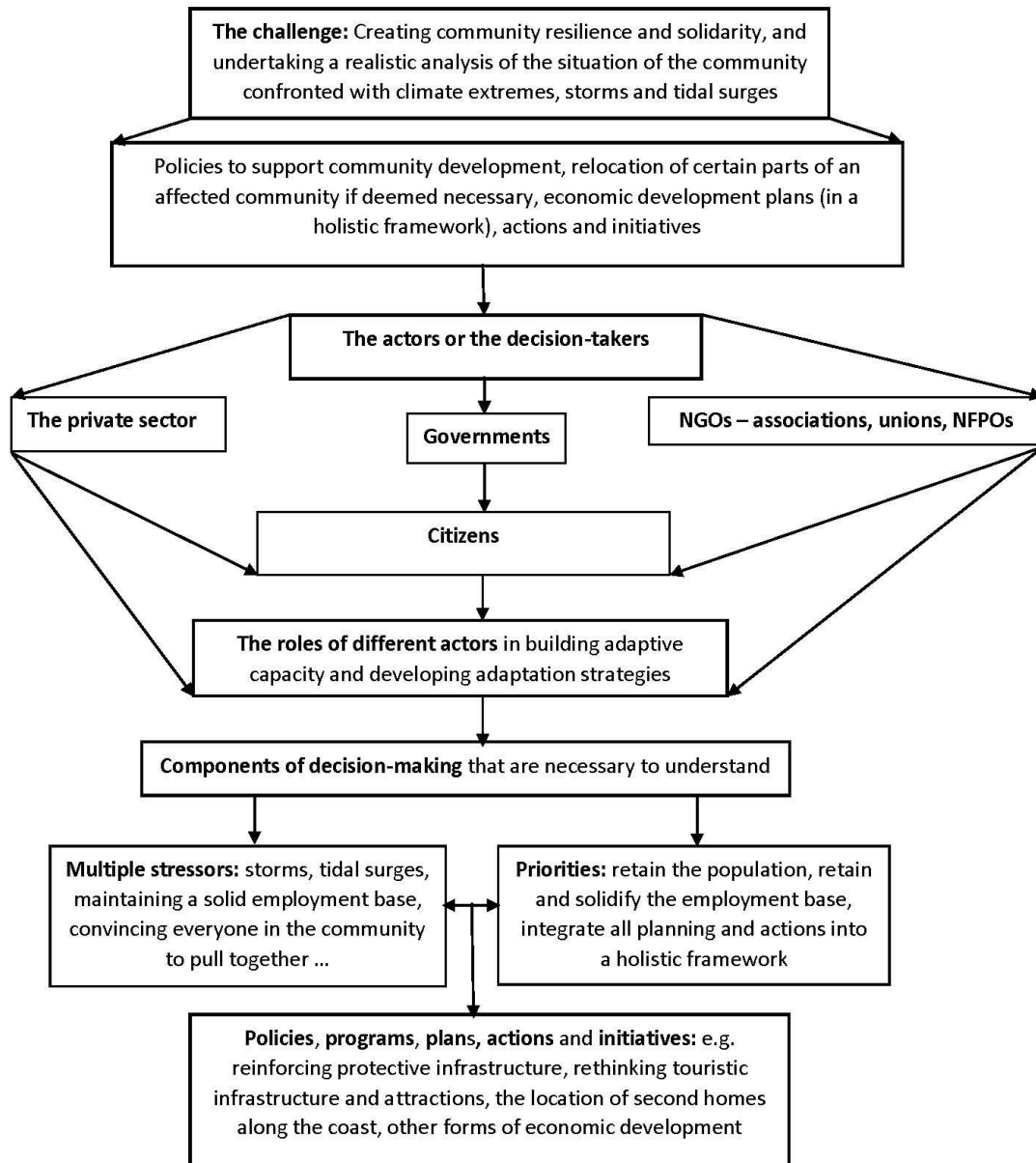
At the same time, some strategies pursued by some farmers have involved investigating and dealing with alternative markets such as the increasing demand for organic produce and produce produced through the use of agro-ecological practices. This reflects not only making changes in relation to CCV but also, and perhaps more importantly, in relation to the changing nature of food produce markets. Depending upon the specific circumstances of agriculture in different regions, appropriate adaptation strategies can also involve more effective water management strategies and water infrastructures (both on individual farms as well as collectively) and the adoption of alternative technologies in farm production.

Finally, it is also important to recognize that strategic planning can be pursued in an agricultural Strategic Orientation for an agricultural territory thus constituting a holistic framework for planning agricultural development that could potentially integrate adaptation of agriculture to CCV. Examples of the construction (even the co-construction) of agricultural development plans for agricultural reserves (Plans de Développement de la Zone Agricole (PDZA) or Agricultural Development Plans) were developed from 2008 to 2011 in a pilot sample of 8 MRCs (Municipalités Régionales de Comté or Regional Municipal Counties) in Quebec, Canada, before being encouraged in other MRCs [45]. In several instances, agrotourism was also integrated into the thinking and discussions that led to the final agricultural development plan. In some other cases, reference also was made to CCV.

## **5. Coastal communities**

Coastal communities of different sizes and in different types of territories (e.g., small islands [46]) have played and continue to play important roles in providing support for the development of several important human activities such as fishing, national and international transportation and tourism, all of which have generated employment for some inhabitants, creating markets for commercial activities and markets for social and health services.

Based upon extensive research in which the lead author was a research partner in the Gaspé region (Quebec) and the Province of New Brunswick [47] and on a broader appreciation of the scientific literature in this domain [35], the principal challenges are to build community solidarity and resilience, and undertake a realistic appraisal of the situation of any coastal community which is confronted by climatic extremes and tidal and storm surges (Figure 5). The policies and actions commonly required include maintaining and enhancing support for community development, developing a holistic strategic development plan and process, and even, if necessary, to consider the relocation of certain parts of the community.



**Figure 5. Coastal communities: building adaptive capacity and adaptation strategies to cope with climate change and variability.**

Building community solidarity is particularly challenging when the municipality (local or regional) covers a wide area with some citizens located near the coast meaning they bear the brunt of the negative consequences of storm surges, tidal surges and sea level rise (SLR) while others may be located much further inland where some citizens may raise questions about why they should be concerned by these disasters when they are not directly affected [47]. However, they are indirectly affected in a substantial way if the CCV storm surges, tidal surges and SLR damage properties beyond repair and require re-building of certain infrastructures, thus requiring expenditures and therefore potentially raising local taxes. The level of services available to the citizens can also potentially be affected if the damages are sufficiently large so that the net result is a decline in overall economic activity.

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Sea level rise (SLR) is a consequence of CCV, and several trade-offs have to be made between environmental, economic, social and cultural values. For some levels of government, the trade-offs can include which coasts to protect and which to abandon [47]. Minimizing the number of trade-offs may be accomplished by combining several adaptation strategies, as has been shown in the Netherlands (see below).

Another challenge for adaptation to CCV is how to deal with uncertainty and the inherent long-term perspective despite a wide range of climate simulations and predictions. It is impossible to provide definitive forecasts on how sea levels will rise in the future [48]. This illustrates how urban planning is constantly confronted with the challenge of protecting existing and prospective settlements without sufficient knowledge of potential threats [49]. To deal with uncertainties, the Netherlands has taken into account a wide range of SLR scenarios to plan for the long-term even though protective infrastructure reinforcement has continued to play an important role [50-52]. Elsewhere such as New York [53] alternative strategies have been used, including placing an emphasis on natural infrastructure to build coastal resilience in urban areas.

The nature of the impacts and consequences of CCV for coastal communities can be substantial and can be linked to extreme storms, tidal surges, SLR and flooding of rivers flowing through the communities. The recurrence of natural disasters has certainly increased over the years [54,55]. In addition, of all natural disasters, floods account for those which have the highest rate of recurrence [56]. Based on the observation that global urbanization is mostly coastal, it is evidently important to emphasize that the management and strategic planning of urban growth in these regions are paramount.

The impacts can damage or even destroy protective coastal and port infrastructures, as well as damaging or destroying tourist infrastructures (beaches, ports) and attractions along coasts that are valuable for certain tourist activities, second homes such as chalets along the coast, and industrial development [55,57]. Examples in recent years include communities along the East Coast of the U.K. and communities along the Thames estuary, some coastal communities in France and Belgium, and communities along the Gaspé Peninsula in Quebec, Canada (see references in [35]).

The different actors involved potentially also include governments at all levels, and it is particularly important for coastal communities given their important roles for society in general that significant efforts are made to ensure productive interaction between all levels of government for the effective management of the situation and in planning for the future development of such communities [58]. As these authors note, the principal blockages that hinder effective management of the risk of floods are: 1) A lack of understanding of the risks and their implications throughout the current and the future city; 2) The lack of long term integrated and comprehensive planning; 3) The lack of control of the role of local and regional authorities ((Ibid, p.85).

The City of Dordrecht in the Netherlands has implemented a management plan including some of these considerations in order to deal with floods aimed at making the city more resilient to this type of hazard and particularly to integrate a “bottom-up” approach as well as putting in place more effective communications between different levels of government (Ibid, p.87).

The private sector with its businesses related to the various economic activities noted earlier also need to be involved in any long term planning process, as do the various NGO's, citizen associations, unions and NFPO's. And of course citizens need to be involved because they are affected in various ways by the impacts of CCV for instance on employment, and also because citizens as well as businesses pay local taxes, and the impacts of CCV on different economic

activities can certainly have negative impacts on local taxes as well as on the level of services available. Unfortunately, there are still many communities, including many coastal communities, where citizens are not integrated nor represented in long term planning efforts.

Once more, the actors involved in coastal communities have to cope with multiple stressors, e.g., not only coping with CCV but also maintaining the employment base in the face of CCV and competition and developing community solidarity in situations when not all segments of a community are impacted in the same way by CCV. This means that consideration has to be given to trade-offs between priorities. To make matters more complicated, these trade-offs are not necessarily seen as the same at different levels of government nor between different local and regional actors. Hence once more we are confronted by the need for long term strategic planning processes that are co-constructed (i.e., for and by the community), and once more it is important for all actors to really understand their roles as well as the roles of other actors, particularly in relation to the different levels of government, when it comes to identifying who can take responsibility for different actions and initiatives and for managing them. It is not necessarily the government (senior, regional or local) which has to take the initiatives and manage them.

Furthermore, the precautionary principle has received an increasing focus in coastal use planning. This means that precautionary measures are taken even if the cause and effect of climate change is not established totally. Enhancing coastal vegetation and protecting coral reefs are among the examples of such measures. For many regions, an important focus of coastal use planning is to use the coast as a natural system to buffer coastal communities from inundation, working with nature rather than against it, as in the Netherlands [52].

The Netherlands provides some interesting and useful examples of proactive adaptation [51] and collective human response. In the Netherlands, collective human response started to play a role in coastal evolution as early as the ninth century, while its influence started to become a major factor during the nineteenth and twentieth centuries [59]. Proactive adaptation has already been taking place, highlighting the success of the water boards as the first democratic institutions in the Netherlands [59]. Also, the combination of different technologies [60,57] and approaches shows that Dutch society has long been receptive to new technologies, approaches, and policies in its dealings with the many water-related challenges. As a result, increasingly viable flood abatement measures and reclamation projects have been put in place, and on increasingly larger scales [59].

## 6. Challenges

There are a number of significant challenges both for research and for the practical issues of identifying and putting in place effective adaptation strategies to cope with CCV particularly in relation to the many actors and their roles in constructing and initiating adaptation strategies. Adaptation to CCV is associated with various complexities, such as multiple scales of interaction and response, the problem of maintaining integration in the face of numerous components and interactions, and the presence of multiple stakeholders with often contrasting objectives that complicate the task of identifying research and management objectives and finding trade-offs between them. For example, agriculture is arguably the sector most affected by climate change, but impact assessments differ and are often difficult to compare. In addition, climate models have produced different results over time due to model refinements [11], which makes it hard to compare one study to other studies that will be using the same methodology as well as climate models (or vice

versa). Moreover, the development of vulnerability indices continues to present a scientific challenge [60].

Another challenge is that of maladaptation, which can occur when there is a focus on insurance against extreme weather conditions as an appropriate form of adaptation. For example, some farmers have sought protection from climatic extremes (and other sources of negative impacts on crop yields) through their participation in crop insurance programs, but this can lead to farmers deciding not to introduce any new adaptation strategies or making any other changes in the farming system, thus opening them up to maladaptation in the long term. However, if appropriate counseling is also associated with crop insurance programs (as in Quebec), this type of maladaptation can be avoided.

Another challenge that has appeared is the need to take account of local knowledge in developing appropriate plans and adaptation strategies (e.g., for agriculture, see [11,60]). This can be considered important in any domain (e.g., agriculture, coastal communities, tourism development...) and underscores the need for local actors to be involved in the development of appropriate adaptation strategies.

A major challenge for senior government representatives in initiatives aimed at encouraging adaptation is to understand the complexities affecting decision-making and adaptation. Decision-makers in different economic sectors, for instance, do not necessarily have the same priorities in different communities, territories or regions even in the same country. Partly this can reflect the presence of different socioeconomic systems of production, and different cultural values including how government is assessed and appreciated (or not). How to take account of the significant diversity of situations geographically? One point is clear and that it is not appropriate to launch initiatives or programs to encourage adaptation by adopting the 'one size fits all' approach, or, in other words, parachuting a model of adaptation into different communities, territories, regions or countries (although of course some basic principles are usually present, but how they are followed through with should respect these differentiating specificities).

A final challenge related to the actors who can and should be involved, and this time specifically for research, is to be able to contribute to providing timely results that are also comprehensible to the decision-makers. This is taken up again in Section 7, the Conclusions.

## 7. Conclusions

To start off, our discussions of the two domains – agriculture and coastal communities – have focused on the range of different actors who should be involved in developing appropriate adaptation strategies. Our discussions have emphasized the need for the actors most directly involved in the activities being affected by CCV to be involved in developing the adaptation strategies, even if it is also important for them to have access to appropriate counseling from other pertinent actors.

It is also important for the actors directly involved in adapting their own activities to have appropriated the significance of CCV. This is obvious but in the research undertaken by the authors of this article the actors such as the farmers had to be convinced of the reality of CCV early on. However, to make progress requires more than recognizing the reality of CCV – it also requires that adapting to CCV and the recurrence of its impacts is given priority. Yet both in the research that the authors have been involved in and the many other studies that have been referred to, coping with CCV was not always given high priority by the actors directly affected. This underscores one of the messages in this article, that it is essential for governments who desire to contribute by providing



support for counseling, or developing programs to facilitate the development and appropriation of pertinent adaptation strategies to recognize the critical importance of involving the actors most affected by CCV impacts and to integrate their local knowledge. This also requires governments to appreciate that many of these actors also have to cope with multiple stressors and may well have different priorities even if they recognize the reality of CCV.

We have also emphasized the importance of integrating adaptation to CCV into a more holistic planning process in order to ensure that adaptation to CCV and CCV itself is not marginalized and rather is recognized for the repercussions that it can have on other activities and projects in the same area. We emphasized the potential of strategic development planning for and by the community, a process that has become increasingly put in place in different municipalities and regions in Canada from the late 1980s onwards. Because of the emphasis in this approach of involving all actors with legitimate interests in what happens in the area, it is not too difficult to integrate new strategic orientations into the ongoing process, such as adapting to CCV. This approach, which requires a great deal of openness on the part of local and regional governments and indeed on the part of all actors involved, is also conducive to the development of appropriate partnerships between different actors.

Our discussions have also noted that much of the research into effective adaptation to CCV has emphasized the importance of recognizing that adaptation is also a diffusion process and that in many situations it is necessary to understand the social networks in which information and experiences are transmitted and integrated into pertinent adaptation strategies in the areas under consideration.

Finally, there is renewed interest in Research Action, in which researchers take on important roles in constructing solutions together with the actors directly concerned. Research Action has become more recognized and used in a number of fields in recent years. Researchers who have adopted this approach have for instance accompanied local actors, including farmers and this has been reported in some recent articles (e.g., [61,62]). In this approach, researchers provide appropriate counseling, information and act as facilitators when the local actors ask them to perform these functions. In the domain of adaptation to CCV, this has included facilitating co-construction processes [59,60] of strategic development plans, initiatives and projects, including various adaptation projects such as adaptation strategies of agriculture to CCV [63,64] and building community and environmental resilience in coastal communities [47]. The potential is enormous but it requires that the research has three basic characteristics on the part of the researchers involved: i) Patience on the part of the researcher; ii) a recognition of the importance of the Process in which different actors are involved and into which new actors may have to be integrated into the discussions at any time; and iii) Participation, meaning that the actors involved are the ones who determine the directions taken by the discussions and the eventual strategies, plans and projects, and not the researcher.

### **Conflict of interest**

The authors declare there is no conflict of interest.

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