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# An innovative interactive mapping tool to present research results: example of a terroir study in the context of climate change

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Over the past decade, Story Map applications have been developed throughout the world under the impetus of software developers in the fields of visualization (Google Earth[1], Neatline[2], TripLine[3]) and geographic information systems (ESRI[4], Knight Lab[5]). These Story Map web applications allow information to be presented, shared and distributed in the form of interactive maps combined with images, text and audiovisual content. Using these tools to transfer the results of research projects is an innovative approach that can be highly effective, with their ease of access and user-friendly interface encouraging users to explore the data. Such a tool has been used to supplement scientific papers reporting the results of a research project on terroir and climate change in the Bordeaux region. The link to access it is https://www.adviclim.eu/storymap[6].

## A research project suited to the implementation of communication in the form of interactive maps

The Life ADVICLIM project aims to study scenarios for adaptation to the impacts of climate change in various European wine regions[7]. The pilot site of Saint-Émilion, Pomerol and their satellites was chosen for the presentation of results in the form of a Story Map. In this study, current and future temperature variability was studied at the local scale and the impact of temperature on vine growth and grape ripening was modeled[8 9]. The impact of climate change on grapevine phenology and production strategies was simulated according to two IPCC[10] scenarios (RCP[11] 4.5 and 8.5) and over two future periods (2031-2050 and 2081-2100)[12]. The last component of this project concerns the mitigation of greenhouse gas (GHG) emissions, studied at the plot level, to identify practices that emit the least $CO_2$[13]. The many maps and graphics produced as part of this research project were particularly suited to distribution in the form of a Story Map.

## Implementation of a Story Map

This choice of implementation meets the need to offer a visualization medium combining maps, graphs and textual data that give context to the issue addressed by the Life ADVICLIM project. Several dedicated Story Map applications are available[14]. The development platform used in this project is based on the "Map Series" framework of Story Maps from ESRI[15]. The ESRI tool has the advantage that it is derived from Geographic Information Systems and is particularly well suited to a multi-scalar approach. It provides various display options, ranging from incorporation of standard text and images to dynamic content from a database (in postgresql/postgis format) and a third-party geo-visualizer (Indigeo[16]). This dynamic content is an original feature of the Story Map, making the visualization experience more immersive for the user. Hence, the data produced as part of this project, illustrating the various items on this Story Map, offers augmented visualizations: data from weather stations in the form of interactive graphs (ManageChart[17]), clickable maps with direct access to the data, and a multi-agent model with a video visualization of its operation.

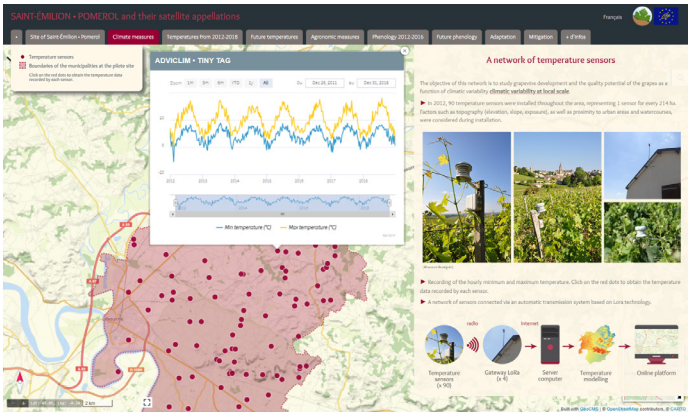


**FIGURE 1.** Structuring of the Story Map with the example of the page on "Climate measurements".

## Structure and presentation of the Story Map tool developed

The effectiveness of the tool lies in the structuring of the story presented. It was decided to divide this project into nine items corresponding to different project actions. Each part is structured with a data visualization window and a simplified presentation of the equipment and method on the right, illustrated with graphs and photos (Figure 1).

Users can thus find most of the project results, including all current and future climate models, in the form of interactive maps with the option to zoom in on selected areas (Figure 2).

All results presented in graph or map form are discussed in the text tab on the right of the window (Figure 2). Highlighted passages in the text redirect to additional content: maps by vintage, index definitions, details of grape varieties, etc. Information from other projects on the terroir of this region, particularly the geology and pedology, has been added to the tool to make it more useful. Bibliographic resources, directly accessible through links underlined in the text, allow users to deepen their knowledge of the topics covered and make the tool accessible to audiences with differing levels of training.

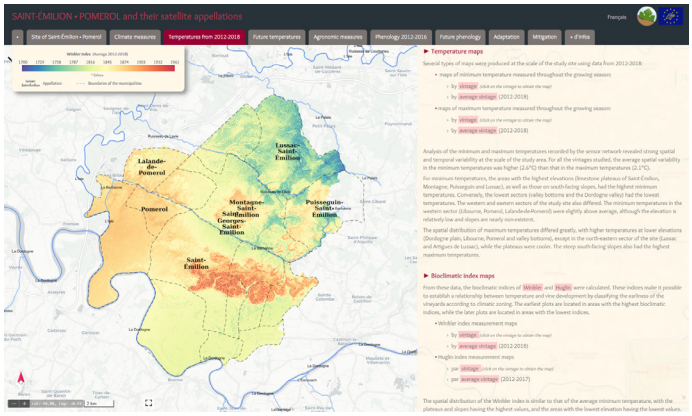


**FIGURE 2.** Map of the Winkler Index measured in the canopy (2012-18 mean).

## Real tool for the transfer of scientific results

Story Maps are quite easy to implement, though they do require mapping and computer skills as the content published must first be formatted using GIS (geographic information system) software. The ESRI suite of GIS tools requires an annual subscription, priced depending on the end use (teaching, research or commercial). Some platforms do offer free Story Map tools (Knight Lab[18]), though with fewer features. Story Map tools are very effective at distributing the results of research projects and presenting data in an original way.

For this project on viticultural terroir in the context of climate change, there were multiple goals:

. Allowing winegrowers in the study area to access data on their production area and their vineyard.

. Raising awareness of climate change in the sector and among policymakers and using this mapping tool to explain, analyze and debate how to adapt to these changes.

. Using this project as an educational tool to introduce the Story Map and its possibilities to students at different levels who are required to report cartographic data. Using it in the classroom or in practical work to provide an interactive way of acquiring skills on viticultural terroir in the face of climate change.

The Story Map tool deployed in this project complements scientific papers published in peer-reviewed journals by making the information accessible to all. Since going online in 2020, this Story Map has had more than 6,400 visits, with peaks of connection noted on the occasion of each event where the tool is presented. This demonstrator presents the results of a research project that is now complete, with no plans to update the published data.

To distribute the results as widely as possible with an international dimension, an English version has also been developed.

## Conclusion

A true scientific communication tool, the Story Map has strong potential for the transfer of research results. It offers many possibilities, ranging from the distribution of results in an original and interactive form, to its use as an educational resource that can be of service to all stakeholders. ■

**1** https://earth.google.com/

**2** https://neatline.org/

**3** https://www.tripline.net/

**4** https://storymaps.arcgis.com/

**5** https://storymap.knightlab.com/

**6** This is the official address of the Story Map, but it redirects to a University of Brest page which hosts all the data

**7** Quénol, H., Marie, G., Barbeau, G., van Leeuwen, C., Hofmann, M., Foss, C., et al. (2014). Adaptation of viticulture to climate change: high resolution observations of adaptation scenario for viticulture: the adviclim european project. *Bull. OIV* 87, 395–406.

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**10** IPCC: Intergovernmental Panel on Climate Change

**11** RCP : Representative Concentration Pathway

**12** Tissot, C., Rouan, M., Petitjean, T., David, L., Le Roux, R., Quénol, H., et al. (2020). Simulating the impact of climate change on viticultural systems in various european vineyards. in *XIIIth International Terroir Congres* (Adelaide, Australia). Available at: https://hal.archives-ouvertes.fr/hal-03094081.

**13** Adoir, E., Penavayre, S., Petitjean, T., and de Rességuier, L. (2019). Study of the viticultural technical itineraries carbon footprint at fine scale. *BIO Web Conf.* 15, 01030. doi: 10.1051/bioconf/20191501030.

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**15** ESRI: a geographic information system (GIS) software publisher

**16** https://indigeo.fr/

**17** https://managechart.univ-brest.fr/

**18** https://storymap.knightlab.com/