NATIONAL PARTNERSHIP
FOR CLIMATE PROJECTIONS

Climate
Systems

National Environmental Science Program

Climate information portals: development and delivery principles

The National Partnership for Climate Projections (NPCP) is a voluntary collaboration of all states and territories, peak science bodies and the Australian Government, in a coordinated approach to deliver high-quality and consistent climate information.

The NPCP Roadmap outlines the vision and expected benefits from this collaboration, and lists all partnership members.

Partners

The Climate System Hub was established in 2020–21 under Phase 2 of the Australian Government's National Environmental Science Program (NESP). The NESP Climate Systems Hub will run until 2026–27. The hub collates research to advance the understanding of Australia's climate; its extremes and associated drivers. This research will directly inform climate adaptation solutions for Australia.

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Acknowledgements

The ‘Climate information portals: development and delivery principles’ (the document) was a collaboration between Working Group 3 Climate Services and User Needs and the National Environmental Science Program (NESP) Climate Systems Hub (Project Synthesis communication and data: Tailored information for stakeholders) . It draws on author’s experiences of developing climate information portals. This document reflects a commitment to work together on shared challenges and opportunities across:

- leading the development of portals providing access to climate projections for Australian states and territories
- engaging with portal users to understand their needs and test prototype portal components
- integrating climate data into online resources supporting climate adaptation
- writing guidance material for portals
- growing understanding of requirements and expectations from users.

Contributors to the document are:

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- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
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- Queensland Government – Department of Environment and Science
- SA Government – Department for Environment and Water
- Tasmanian Government – Renewables, Climate and Future Industries Tasmania
- Victorian Government – Department of Energy, Environment, and Climate Action
- WA Government – Department of Water and Environmental Regulation
- Coast Adapt – Griffith University.

Endorsement of climate information portals – development and delivery principles

This ‘Climate information portals: development and delivery principles’ document is endorsed by the National Partnership for Climate Projections. These principles are not binding and do not displace existing governance and decision-making processes.

Executive summary

The principles described in this document are intended for use by portal developers and draw from a foundation of experience to guide future development. The overall aim of these principles is for a more consistent and comparable approach to delivering future climate information through portals.

As the quantity and quality of climate information grows – with advances in modelling and new methods for climate projections – there is a need to transfer knowledge and engage with a rapidly growing and varied audience. Online climate information portals are a common way to achieve this. New or upgraded portals continue to be developed by the public sector in all Australian jurisdictions, complemented by work from entities such as commercial service providers.

The principles in this document are intended to apply to portals providing historical data and/or climate change projections for decision-makers and other users of climate data in jurisdictions across Australia. The portals:

- are more than just a catalogue of other websites or documents
- target a general or a more specific audience (for example, defined by sectors, systems or values)
- provide a range of metrics, tools, and/or narrative descriptions that require different levels of scientific and/or statistical understanding.

Some examples of existing portals include:

South Australian climate projections viewer

Victoria's Future Climate Tool

Queensland Future Climate Dashboard

Interactive climate change projections map | AdaptNSW

Regional Climate Change Explorer

My Climate View

Introduction

Definitions and context

This document provides guiding principles for public sector portal developers, supporting a more consistent and comparable approach to delivering climate information to a range of users. The intent is to help developers be more efficient and effective in planning, designing, delivering and maintaining portals.

A climate projection is an estimate of how climate will develop under different scenarios and forcing (mainly greenhouse gases). 'Climate' in this context means the broad statistics of the atmosphere, land, oceans and cryosphere (snow cover, glaciers, permafrost, sea/lake/river ice) including their averages, variability and extremes. Climate projections are generally made over periods of 2 or more decades and aim to describe the range of future climate states that are possible for a given climate forcing.

'Portals' can be referred to by various names, such as 'platforms', 'gateways', or 'dashboards', and in many cases these terms are used interchangeably. A 'portal' is different than a website that presents the same content for all users; it is interactive and provides different content for different users. We also draw the distinction between a portal (or gateway/dashboard) and a 'data platform', where the latter is aimed primarily at delivering data. The goal of a climate portal is to distil, visualise, and provide access to relevant past, present and future climate information from global and regional climate datasets. It does this in a way that is comprehensive and actionable for the intended audience, who may have limited or no climate science background, rather than simply serving up data. Some of the defining aspects of a portal are that it provides a single point of access to domain-specific information, and that users are able to interact with it and be provided with content that is specific to their needs. See Appendix A for a detailed comparison of the terms listed in this section.

Development and delivery principles

The principles were assembled by the authors during, prior to and after an online workshop held in November 2023. There are 8 broad principles described below and in Figure 1 that relate to the ideal properties of a climate information portal.

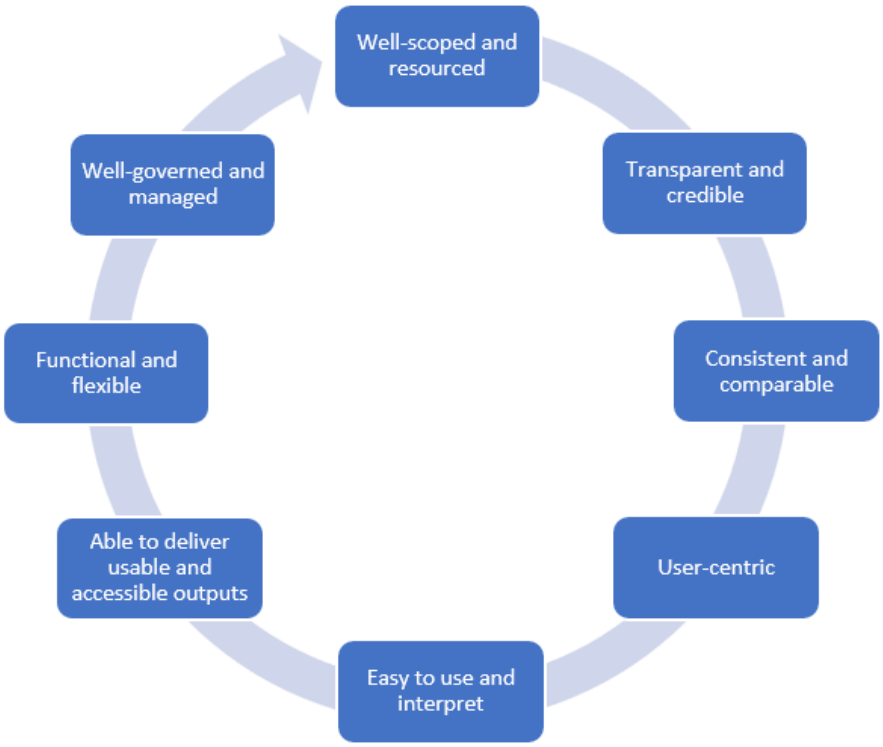

Figure 1: Broad principles relating to the ideal properties of a climate information portal

1. Well-scoped and resourced

At the outset of a portal development project, the need for a new portal should be established, the target audience identified, and the resources required for the full lifecycle of the portal considered.

2. Transparent and credible

The underpinning data and sources need to be clear and easy to find, with links to:

- the methods used to generate output
- related research papers
- evaluations that demonstrate the data are fit for purpose.

3. Consistent and comparable

Future climate information needs to be comparable across local, regional and national scales and between different portals.

4. User-centric

Developers should understand their audience, their climate literacy, data-handling capabilities, capacity, information needs, decision-making processes, and how they will use the portal.

5. Easy to use and interpret

Portals should be easy to use and interpret for a range of climate literacy levels and data-handling capabilities, and provide fit-for-purpose information in a way that makes data and information-discovery time-efficient for the user.

6. Able to deliver usable and accessible outputs

Portal outputs should deliver information in a range of formats which support ease of use.

7. Functional and flexible

Data visualisation should be flexible and functional, with the ability for users to choose options and parameters to suit their needs.

8. Well-governed and managed

Governance and management over the planned lifetime of the portal are important considerations for all stages of development.

Processes supporting the principles

This section describes the key points for each of the broad principles listed above.

1. Well-scoped and resourced

1.1 Before developing a new portal, firmly establish the case for one and carefully consider the potential portal's goals

- Consider the rationale and justification for developing a portal. Perhaps your project aims to develop new climate projections or host data not available elsewhere, or your agency is keen to develop a new climate presence. Before these steps are taken, consider whether a new portal will solve user needs or instead add to existing pain points from too much information.
- Don't assume that a new portal is the best or only solution. Consider the outcomes sought, resources available, user needs, existing offerings and ability to support and fund a portal over time. A climate portal takes considerable time, money and expertise to design, develop, test, maintain and support.
- Before undertaking a portal development, understand the nature of the problem your users are trying to solve. Seek input from them about their information and data preferences. Users' data needs may change or evolve over time, so consider whether your climate portal will still support future use cases.
- Consider working within the existing range of portals, looking to build on existing capability.

1.2 Know your target audience from the beginning

- Portals should be clear for their audience. Determine which types of users are in scope and, importantly, which are out of scope. Establish how specialised or general the information the portal conveys will be at the outset of the design process. Don't be afraid of limiting the intended user group and articulating who the portal does not cater for.
- Gather and document user needs and use cases in the initial phase of portal development before embarking on design solutions. This phase should involve deep engagement with users to build representative priority use cases. Relevant use cases should be documented in enough detail to support decision-making throughout the development process. Use cases can be expressed as user stories that should inform portal functionality and feature design.

1.3 Perform a horizon scan of existing portals before developing a new portal

- Assess existing portal offerings and make sure your new portal would add value. There are at least 18 existing Australian climate portals, so before developing a new one, conduct a gap and cost analysis. Assess whether it is a better use of resources to collaborate with an existing portal manager to extend their data or functionality.
- The review of climate portals should be documented and include:
    - the data offering, features and functionality, information and guidance
    - user experience and accessibility of the information (science translation) for use (key takeaways, actionable information, clear metadata).
- Identify individuals or organisations involved in the development of other portals who may be able to provide advice.

1.4 Ensure sufficient resources are available to develop and maintain the portal

- The project team should include dedicated professional user experience (UX) practitioners and knowledge brokers to assist with developing and refining use cases. Designing a usable and useful application requires these practitioners to be involved early in the development process.
- Consider funding to reimburse users for their time to invest in co-design and co-development to ensure adequate engagement.
- Account for costs for support of the portal throughout its intended lifetime, including ongoing IT, science, user support, and hosting – which can cost thousands of dollars per month for data charges alone.
- Develop a robust business model to ensure funding is available to cover all development and maintenance expenses for the intended lifetime of the portal.
- Service level agreement (SLA) about hosting performance and support level must be considered when sourcing a host.

2. Transparent and credible

2.1 All information shown on the portal should be clearly described, with the source of the data so that it can be cited/referenced

- Data should be available for all graphical products.
- Metadata for datasets available on a portal should be well-structured, easily discoverable and downloadable.

- Sources that help demonstrate the credibility and robustness of the information available should be identified, such as supporting scientific papers.
- 'How to cite' information should be given for all portal material, including documents, data, graphics, webpages and videos. For example, where projections from multiple climate modelling generations or projects are available, it should be possible to cite them individually so it's clear which modelling applies to downstream work.
- Data and content that can be accessed via the portal should have clear date stamps when downloading or printing data.
- Communicate the uncertainties and confidence in projections. Statements about uncertainty, confidence and likelihood should be included in the presentation of the data; ideally, they would draw on multiple lines of scientific evidence (observed trends, changes to climate drivers) as well as climate projections.
- Uncertainty and confidence need to be clearly explained in terms understandable for the intended users. Language around uncertainty and confidence should be co-designed with users.
- Terminology around uncertainty and confidence should be included in a glossary and/or frequently asked questions (FAQs).

2.2 Model projections should display a range of possible climate futures

- Model projections should include a range of possible climate futures and provide, or link to, resources that explain the rationale behind the range of potential outcomes. The range of future scenarios may be influenced by variables in the behaviour of the target users.

3. Consistent and comparable

3.1 Aim for consistent information (or at least not conflicting information) across different climate portals

- Scan climate information portals which provide similar information for your region/sector and where possible apply consistent and comparable methodologies. Ensure you are not providing conflicting information that will confuse users.

3.2 Portals should support multiple generations of climate projections for users who may benefit from this and enhance understanding of how each generation is different (or similar)

- Summary statistics and key messages should be provided that describe how key aspects of regional climate (such as winter rainfall change in Western Australia) are different (or similar) between different generations of climate models. This information needs to be carefully crafted so all users understand what has changed, what has not, and the implications for them.
- Portals should describe how often the climate projections will be updated. Distinctions between timescales for updated projections information and timescales for updated regional downscaling should be made clear.
- Where a portal contains content that supersedes previous projections or other information, the superseded information should be referenced. Alternatively, consider if both previous and new projections should be shown.

4. User-centric

4.1 User needs and use cases – design the portal to meet the needs of intended users

- Match climate information, functionality and guidance to documented use cases. Consider providing the same information in different ways to cater for different types of user personas (for example, CoastAdapt caters for 'skimmers, divers and waders'[1] and the NESP Climate Systems Hub has identified Alf, Bob and Carol personas[2]).
- Consider how the portal will be used within other decision-making or analytical processes and whether the interface can be designed in a way that supports those processes.
- Users with different levels of climate literacy should have access to consistent information. Ideally, tailor data to multiple types of users. Ensure messages to different types of users are consistent across the portal.

4.2 Involve users in the design process

- The development process should employ user centred design, a process and practice involving specific expertise and, critically, frequent user engagement for validation.
- Intended portal users should be included throughout the design and testing process, not just at the beginning and the end. A user reference group comprising real users is one way this can be achieved.
- The design process should involve multiple rounds of deep user testing involving a limited number of high-value or representative users from different user groups. This should extend to sessions in which users are observed while they navigate a prototype portal (formal usability testing UX method). This mitigates the risk of more superficial engagement with large numbers of users that results in the portal being too general in nature.
- Consider the information required for your users to inform their decisions, including specific climate variables or metrics relevant for their interests. For example, some users may not have an interest in how much the average temperature rises but rather understand changes in the frequency and duration of heatwaves.
- Consider whether users need raw data or pre-calculated/on-the-fly calculations of impact-relevant indices (such as agriculture-related climate indices, heatwave metrics).

4.3 Policy and decision relevance

- Consider the decision-making purposes and context of a range of users; for example, information based on global warming levels aligned with the Paris Agreement may be more useful for policy analysis or high-level risk modelling. Information based on emissions scenarios may be appropriate for more targeted risk assessments, planning adaptation responses or developing investment plans.

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[1] Palutikof, J.P., Rissik, D., Webb, S. *et al.* CoastAdapt: an adaptation decision support framework for Australia's coastal managers. *Climatic Change* **153**, 491–507 (2019). https://doi.org/10.1007/s10584-018-2200-8

[2] Understanding-our-audience-3-personas.pdf (nesp2climate.com.au)

4.4 Providers should understand objectives of and constraints on users (such as limits on climate science expertise, time to assimilate information, deadlines, regulatory requirements)

- Portals should provide guidance for users to easily choose the information for their needs. Users may come to a portal following guidance or specific requirements from other sources, such as a risk assessment methodology or compliance standards.
- The portal should help users be accountable for their downstream decisions, by providing an audit trail.
- Portal developers should consider the data volumes and formats that intended users can handle.
- Developers should consider guidelines or regulations that users may need to adhere to. For example, Australian Government Treasury mandatory climate-related financial disclosures[3] require that at least 2 possible future climate scenarios be considered and one of these scenarios must be consistent with limiting global warming to 1.5°C (relative to the pre-industrial climate).

5. Easy to use and interpret

5.1 Usability and accessibility – users should have to make as few choices as possible (the provider should deliver tailored information as much as they are qualified to do so)

- The portal should provide the best information for users' purposes – don't expect users to make the choices. A decision tree (flowchart) may provide a way to guide users to the best information for their needs.
- Portal developers should consider a layered approach to information. The portal may first present users with summary information, but then allow them to drill down to get more detailed or tailored information if required.
- Portals should include worked examples linked to specific purposes to guide users on how to use the information available to make certain types of decisions. Case studies and factsheets are useful.

5.2 Projections need to be given for multiple emissions scenarios

- Put the different projections that use different types on emission scenarios into context, integrating with historical/baseline data.
- Emissions scenarios should align with common external guidance on scenario selection used by the target audience.
- Help users select the most appropriate scenarios for an application (such as by use of a decision tree).
- Requests from users are often to 'make it simpler' and 'people just want one scenario'. This can be often hard to communicate, but it is important for scientists to give reasons why more scenarios are needed and to work with the design team to communicate ranges in projections.
- For some users, portals may need to provide suitable scenarios for assessing both physical risks (like risks to humans or natural systems as a direct result of climate-

[3] Mandatory climate-related financial disclosures - Policy position statement (treasury.gov.au)

related hazards) and transition risks (that is, risks arising from our responses to climate change).

5.3 Consider accessibility

- All portals must be designed using WCAG standards[4] or at least be aligned to Australian government best advice on accessibility[5].
- Alternative text should be available for visual content like maps, charts, graphics and tables.
- Accessibility depends on informed design, development, content authoring, testing, remediation skillsets.
- Best practice is to employ an accessibility consultant to validate/test your portal before release with enough time for remediation of issues. Compile a list of what users often misunderstand or get wrong and provide FAQ. Each type of user should be able to efficiently access the data and information they need.
- Users should be able to access the information they need with as few mouse clicks as possible.
- Providing different types of users with easy access to information may mean having several different pathways to the same information in place.

6. Able to deliver usable and accessible outputs

6.1 Outputs - downloadable content in appropriate formats

- Downloadable summary reports, tables, maps, graphics that can easily be embedded in other documents (such as high-resolution versions).
- Data should be provided in fit-for-purpose formats that are easy to use and apply in users' preferred environments. This may involve converting netCDF data[6] to formats such as delimited text (e.g. csv), spreadsheets (e.g. xlsx) or spatial layers (e.g. shapefiles or GeoTIFF[7]) for integration into users' decision-support systems.
- Graphics should be downloadable in various formats: png/jpg for images; GeoTIFF and shapefiles; vector graphics for modification by simple design software.

6.2 Appropriate metadata, governance, and data management

- All outputs should always travel with a source (e.g. NESP Climate Systems Hub etc) and potentially a date stamp too.
- Date of information and referencing (including latest supporting publications) needs to be easily findable on the platform/portal itself.
- Data needs to have appropriate governance requirements attached, so users are clear on what it can be used for and how it should be attributed.
- Downloadable outputs need to be accompanied by file size description; for example, 145 Mb or 5 Gb.

[4] The WCAG 2 Documents | Web Accessibility Initiative (WAI) | W3C
[5] Accessibility | myGov
[6] Climatological gridded data information – Australian Maps
[7] GEOTIFF Definition | GIS Dictionary

- All outputs should include a link to the head product/website. Include a 'further information' or 'contact us' component as standard.

6.3 Downloadable portal content should be accompanied by guidance and case studies

- Links to case studies describing how content has been previously used should be available where possible.
- Provide worked through example applications to demonstrate the translation of data into application, appropriate use of the application for different purposes, and how uncertainties should be considered.

6.4 Interoperable and reusable data

- Try to ensure the data and information is interoperable and can be ingested into other portals.
- Use flexible design to enable future interoperability to allow linking climate information with vulnerability/exposure data and for downstream modelling.

6.5 Portals should provide actionable and/or relevant information

- Graphics need to be able to stand alone as a single source of information; i.e. the different levels of climate literacy also need to be considered in all outputs.
- Actionable information requires context, summaries, key takeaways, clear recommendations and so on; not just making the data available.
- Consider providing generic consensus statements that users can cut and paste into their reports, without need for extensive editing.
- Provide examples of how you use the information provided in practice/to inform decisions.

7. Functional and flexible

7.1 Data visualisation features should be driven by user needs

- It may not be necessary to provide visualisation for users who already have the capability to quickly and easily visualise data outputs.
- Maps need a clear legend and key, and the ability to show underlying data and links to where data layers can be downloaded.
- Data visualisation features can be computationally intensive and slow to load large datasets – needs to be technically well engineered to make usable.
- Story-telling visualisations should be considered as a way to build understanding without large load times and overwhelming complexity.
- Define the user persona or use case you are catering to and explain why you have visualised the data in a certain way.
- Offer the flexibility to easily switch between visualisation types tailored to different users.

7.2 Allows integration of data at multiple scales (e.g. catchment to regional scales)

- Only allow data to be provided at an appropriate scale. Some data should not be applied at fine spatial scales.

- Presenting data in user-defined spatial boundaries – such as catchment boundaries, Bureau of Meteorology forecast districts/Natural Resource Management regions, local government areas – allows users to place information where it's relevant to their needs.
- Align visualisation functionality with data access functionality.
- Visualisations should support the user making choices about what data to access.

7.3 Make the underlying assumptions for visuals very clear

- Maps should clearly show the spatial resolution and underlying climate projections used. For example, showing a map with a variable or climate-related hazard, allows the user to easily see the underpinning assumption not just the source (e.g. VCP19 CMIP5 projections) but the numbers used (e.g. 8% annual decline of rainfall in for Victoria or 0.5 m sea level rise) that contribute to the mapped flood extent.

8. Well-governed and managed

8.1 Approach to data governance and stewardship, including resourcing and lifecycle

- Consider the lifecycle of the portal (design, implementation, maintenance/support, development, decommissioning).
- Plans to update the portal based on user feedback and new data; e.g. CMIP5 to CMIP6.
- Plans to retire the portal if alternatives become available; have this lifecycle information available on the portal for transparency.
- Consider moving from a beta release (restricted access) to publicly available information.
- Consider needs for training as a support activity.
- Consider the portal as part of a broader service provision – portal not as a standalone since it will not be able to deliver everything to everybody.
- Consider how to support the backend – in house or outsourced.

8.2 Establish good governance and evaluation at the start of the portal project

- Portals should have a formal user reference group to ensure users are kept engaged and informed with a clear pathway for input to co-design. Group members can be champions for the portal in their communities (see also 4.2).
- Have a clear process for adding content to the portal. Standards and guidelines for portal content should be established and documented, together with an approval process for checking these have been adhered to and making the final decision on new content.
- Persistence of underlying information sources should be a consideration on whether content is added. The portal should have a monitoring and evaluation effort, with key performance indicators established and testimonials from users collected so that success and value for money can be assessed. To inform this assessment, the full costs of building and maintaining the portal should be tracked and recorded accurately.

Appendix A: detailed comparison of the terms ‘website’, ‘portal’ (or ‘gateway’ or ‘dashboard’) and a ‘data platform’

Key differences	Website	Portal (or ‘gateway’ or ‘dashboard’)	Data platform
Function	Websites tend to provide general purpose information to a range of public users and use cases.	Portals seek to provide curated information to specific user groups with niche use cases.	Data platforms deliver data to specific users, frequently within a private domain.
Access	Public – accessible via a public URL.	Public/private – frequently developed for registered users managed via database accounts.	Public/private – provides access to downloadable data to registered users managed via database accounts.
Content	Varied – commercial, private, public and not for profit, but frequently less data rich and less commercially sensitive.	Varied – commercial, private, public and not for profit, frequently data rich and commercially sensitive.	Frequently involving RESTful data services: incorporating an application programming interface (API) to act as a bridge, enabling the exchange of data, features and functionalities between applications.
User engagement	Websites are commonly developed to support brief, transactional user interactions. Session durations tend to be short.	Provides a 2-way communication between user and portal. Portals tend to support deeper user engagement with content, acting as an online resource for a domain topic. Session durations tend to be longer.	Data platforms frequently support functionality that enables data investigation, transformation, and procurement. Sessions times are generally matched to data downloads.

Key differences	Website	Portal (or 'gateway' or 'dashboard')	Data platform
Domains	Websites exists for a variety of public domains and tend to be shallower in content.	Portals tend to support niche domains with emphasis on becoming an established resource.	Data platforms exist for myriad public and private domains where data is exchanged.
Implementation	Websites can vary in development implementation but commonly focus on supporting mobile devices, and utilise a 'thick-client'[8] programmatic approach.	Portals are also varied in implementation approach but tend to be preferentially developed for users on desktop platforms, also using a 'thick-client'[8] programmatic approach.	Data platforms tend to be preferentially developed for users on desktop platforms and involve more complex back-end functionality (server-side programmatic approach).
Target users	Websites typically render the same content for all users, and are designed for a wide array of use cases, typically in more generic domains (shopping, entertainment, etc)	Portals may render content differently for specific users and support more niche domains (e.g. future climate information, finance, planning, etc).	Data platforms are typically designed for more advanced users of data within specific domains (geo-spatial, development, scientific, etc).

[8] A 'thick client' can operate without connecting to a remote server, and can therefore work in offline mode.