Comments from Public Consultation on ECV Requirements 13/01 – 13/03 2020 for:

# Land cover

## ECV Product: Maps of key IPCC land use, related changes and land management types

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| **Name** | Maps of key IPCC land use, related changes and land management types | | | | |
| **Definition** | Land cover is defined as the observed (bio)- physical cover on the Earth’s surface | | | | |
| **Unit** | Primary units are categories (binary variables such as forest or cropland) or continuous variables classifiers (e.g. fraction of tree canopy cover in percent). Secondary outputs include surface area of land cover/use types and land cover/use changes (in ha). | | | | |
| **Note** | The observed (bio)- physical cover on the Earth’s surface can also be variable in time due to land changes and phenology. Crucially, this table refers to change products. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | M / degree | Size of grid cell | G | 10-300 | This would allow finer detail to be observed, and for land management to be assessed at smaller units. |
| B | 300-1000 | For most climate users, 300 m is sufficient. |
| T | 1000-1 degree | For modelling for example at the global scale, this resolution is sufficient.  More detailed land cover descriptions are more targeted for regional applications in climate change mitigation and adaptation purposes. |
| **Vertical Resolution** | Set to NA since ECV products provide estimates as total over a certain area with further vertical discrimination. There is currently no consideration of the third dimension for land ECV products though some of the definitions (such as forests) often use, among others, a minimum height criteria. | | | | |
| **Temporal Resolution** |  |  | G | Monthly | Allows regrowth, phenology, changes in water extent related to seasonality to be detected. |
| B | Yearly | Inter-annual changes can be detected. Suitable for most international and national policy reporting cycles. |
| T | 5-yearly | Suitable scale for longer-term mapping, related to broader land cover change dynamics. |
| **Timeliness** |  |  | G | Monthly | Ideally, land cover data become available soon after the acquisition of the data but quality processing and ECV product derivation and accuracy assessment, as well as, long-term consistency is to be ensured to track changes and trends. |
| B | Yearly | Policy makers will be able to develop and assess policies based on these changes. |
| T | 5-yearly | As above. |
| **Temporal Extent (Time span)** | Year |  | G | >100 years | For modelling over longer histories historic data are required. |
| B | 50 years | Near historic changes can be assessed. |
| T | 30 years | Only current maps using the current generation of satellites are used. |
| **Required Measurement Uncertainty** | % for accuracy and errors of omission and commission and hectares for area estimates incl. 95 % confidence intervals | Primary: overall map accuracy and errors of omission and commission for individual land cover categories and types of change (incl. confidence interval). Secondary: bias for area estimates (incl. confidence intervals) | G | 5 | For reporting purposes, this would allow sufficient accuracy, where all classes have high accuracies. |
| B | 15 | For other uses, this would be sufficient – it would be expected that some classes would have higher accuracy -for example confusion between built-up and forest would be lower, but confusion between agriculture and bare might be higher. |
| T | 25 | This threshold would be suitable for maximum commission/omission error for individual categories. Overall accuracy might be expected to be higher |
| **Stability** | % incl. 95 % confidence intervals | Primary: errors of omission and commission for individual land cover categories and types of change (incl. confidence interval) | G | 5 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| B | 15 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| T | 25 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| **Standards and References** |  | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Not for all cases | Adaptation interventions per land cover can be planned, and changes in land cover can be seen as adaptation interventions in themselves (i.e. increased forest cover supports water cycling, reduces soil erosion and cools cities). One adaptation need will be to accommodate sea level rise and coastal erosion (which may be due to storm frequency so is relevant in the context of extremes), and this change from land mass to sea is relevant for land cover.  Largely, in that land cover specific interventions can be planned and land cover changes observed. High resolution land cover maps would be better suited (10-30 m and 5 year frequency). At present, land cover maps do not necessarily capture changes in boundaries between land and sea, as they may be produced with a fixed land surface mask. | | |
| **Extremes[3]** | Yes | Not for all cases | The Land Cover ECV cannot be directly used to monitor climate extremes, however long-term influences of these climate extremes can be captured where they result in a change in land cover.  It can capture some relevant long-term land cover changes which can be triggered by frequent climate extremes, for example desertification (change from forest/cropland/grassland to other land), melting snow/ice where this class is present (this might be better captured in some of the other EVCs related to ice/snow), drying wetlands. Subtle land cover changes could be more easily captured by fractional products, and fast events which do not result in long-term impacts cannot be capture | | |

[1]Goal (G); Breakthrough (B)(not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

### Comment 1

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| Author: Nic Bax | Email: nic.bax@csiro.au |
| I am interested in the number and description of categories used for this variable. These would be especially important for guiding adaptation. From my cursory examination of documents that I could find online, there seem to be some categories that are recognized as lacking eg. wetlands, mangroves(?), but perhaps this has been updated from the 2017 document that I read. The categories seem primarily designed to support earth systems modelling which would not necessarily support the spatial scale and discrimination necessary to support adaptation. Additionally the categories seem perhaps to be defined by what can be distinguished from remote sensing. This would also limit the discrimination of this ECV and hence its applicability to adaptation. The fixed land surface mask would I imagine also miss the loss of coastline and associated mangrove and wetland habitat. Is there a more complete description of this ECV available? Thanks. | |

## ECV Product: Maps of High Resolution Land Cover

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| **Name** | Maps of High Resolution Land Cover | | | | |
| **Definition** | Land cover is defined as the observed (bio)- physical cover on the Earth’s surface | | | | |
| **Unit** | Primary units are categories (binary variables such as forest or cropland) or continuous variables classifiers (e.g. fraction of tree canopy cover in percent). Secondary outputs include surface area of land cover/use types and land cover/use changes (in ha). | | | | |
| **Note** | The observed (bio)- physical cover on the Earth’s surface can also be variable in time due to land changes and phenology. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | m | Size of grid cell | G | <10 | Suitable for local land managers - specifically for targeted applications in climate change mitigation and adaptation. Small features such as green spaces within cities are visible and changes to water extent (in particular change in river courses) also become visible at this resolution. More detailed land cover descriptions are more. |
| B | 10-30 | Can identify human induced land change at regional levels. Most features of interest are visible, and broad changes captured. |
| T | 30-100 | Broad landscape typologies and changes across landscapes are visible, so suitable for landscape management. |
| **Vertical Resolution** | Set to NA since ECV products provide estimates as total over a certain area with further vertical discrimination. There is currently no consideration of the third dimension for land ECV products though some of the definitions (such as forests) often use, among others, a minimum height criteria | | | | |
| **Temporal Resolution** | Month / Year |  | G | Monthly | Allows regrowth, phenology, changes in water extent related to seasonality to be detected. |
| B | Yearly | Inter-annual changes can be detected |
| T | 5-yearly | Suitable scale for longer-term mapping, related to broader land cover change dynamics. |
| **Timeliness** | Month / Year |  | G | 1-2 Months | Ideally, land cover data become available soon after the acquisition of the data but quality processing and ECV product derivation and accuracy assessment, as well as, long-term consistency is to be ensured to track changes and trends. These frequent changes may be relevant for land managers who can react quickly to changes. |
| B | Yearly | Annual and bi-annual reporting applications. Policy makers will be able to develop and assess policies based on regular updates and observed changes. |
| T | 5-yearly | As above. |
| **Temporal Extent (Time span)** | Year |  | G | -30-50 | Historic changes which most users are interested in are captured. Only be achieved with modeling approaches using non-earth observation data sources (i.e. historical maps) – where more recent high resolution data sources (Landsat, Sentinel) are not available. |
| B | 10-30 | Historic changes can be assessed for the Earth observation data which are required at this resolution. |
| T | One time only (0) | Only current and potentially future data are available, but this is useful for those who require current status products, for example for modelling, and static assessments. |
| **Required Measurement Uncertainty** | % for accuracy and errors of omission and commission and hectares for area estimates incl. 95 % confidence intervals | Primary: overall map accuracy and errors of omission and commission for individual land cover categories and types of change (incl. confidence interval). Secondary: bias for area estimates (incl. confidence intervals) | G | 5 | For reporting purposes, this would allow sufficient accuracy, where all classes have high accuracies. An independent accuracy assessment using statistically robust, global or regional reference data of higher quality is required for any ECV land cover product. |
| B | 20 | For other uses, this would be sufficient – it would be expected that some classes would have higher accuracy -for example confusion between built-up and forest would be lower, but confusion between agriculture and bare might be higher. An independent accuracy assessment using statistically robust, global or regional reference data of higher quality is required for any ECV land cover product. |
| T | 35 | This threshold would be suitable for maximum commission/omission error for individual categories. Overall accuracy might be expected to be higher. An independent accuracy assessment using statistically robust, global or regional reference data of higher quality is required for any ECV land cover product. |
| **Stability** | % incl. 95 % confidence intervals | Primary: errors of omission and commission for individual land cover categories and types of change (incl. confidence interval) | G | 5 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| B | 15 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| T | 25 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| **Standards and References** |  | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Not for all cases | Adaptation interventions per land cover can be planned, and changes in land cover can be seen as adaptation interventions in themselves (i.e. increased forest cover supports water cycling, reduces soil erosion and cools cities). One adaptation need will be to accommodate sea level rise and coastal erosion (which may be due to storm frequency so is relevant in the context of extremes), and this change from land mass to sea is relevant for land cover.  Largely, in that land cover specific interventions can be planned and land cover changes observed. High resolution land cover maps would be better suited (10-30 m and 5 year frequency). At present, land cover maps do not necessarily capture changes in boundaries between land and sea, as they may be produced with a fixed land surface mask. | | |
| **Extremes[3]** | Yes | Not for all cases | The Land Cover ECV cannot be directly used to monitor climate extremes, however long-term influences of these climate extremes can be captured where they result in a change in land cover.  It can capture some relevant long-term land cover changes which can be triggered by frequent climate extremes, for example desertification (change from forest/cropland/grassland to other land), melting snow/ice where this class is present (this might be better captured in some of the other EVCs related to ice/snow), drying wetlands. Subtle land cover changes could be more easily captured by fractional products, and fast events which do not result in long-term impacts cannot be capture | | |

[1]Goal (G); Breakthrough (B)(not mandatory, more as one possible); Threshold (T), for definitions see [Guidelines](http://tiny.cc/ecv-review)

[2] Is the ECV Product directly relevant to support Climate Adaptation?

[3] Can the ECV Product be used to monitor climate extremes or aspects of extremes?

### Comment 1

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| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| Land cover is a key product for global modelling monitoring and forecasting. A 1km annual land cover that can support water energy and carbon fluxes specification (including the main natural biomes and anthropogenic use of land) is of paramount importance. Land cover need to be interconsistent with water fraction, biomass, leaf area index, urban cover. | |

## ECV Product: Land Cover

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| **Note** | The observed (bio)- physical cover on the Earth’s surface can also be variable in time due to land changes and phenology. | | | | |
| **Requirements** | | | | | |
| **Item needed** | **Unit** | **Metric** | **[1]** | **Value** | **Derivation and References and Standards** |
| **Horizontal Resolution** | m | Size of grid cell | G | 100-300 | Most climate users are satisfied by a horizontal resolutions of 300 m if they can be provided for long time spans. |
| B | 300-1 km | Suitable for regional (climate) modeling. |
| T | >1 km | Suitable for global (climate) modelers. |
| **Vertical Resolution** | Set to NA since ECV products provide estimates as total over a certain area with further vertical discrimination. There is currently no consideration of the third dimension for land ECV products though some of the definitions (such as forests) often use, among others, a minimum height criteria | | | | |
| **Temporal Resolution** | Month / Year | time | G | Monthly | Allows regrowth, phenology, changes in water extent related to seasonality to be detected. |
| B | Yearly | Inter-annual changes can be detected. |
| T | 5-yearly | Suitable scale for longer-term mapping, related to broader land cover change dynamics. |
| **Timeliness** | Month / Year |  | G | Seasonally (3 months) | Ideally, land cover data become available soon after the acquisition of the data but quality processing and ECV product derivation and accuracy assessment, as well as, long-term consistency is to be ensured to track changes and trends. These frequent changes may be relevant for land managers who can react quickly to changes. |
| B | Yearly | Annual and bi-annual reporting applications. Policy makers will be able to develop and assess policies based on regular updates and observed changes. |
| T | 5-yearly | As above. |
| **Temporal Extent (Time span)** | Year |  | G | 50+ years | Historic changes which most users are interested in are captured. Only be achieved with modeling approaches using non-earth observation data sources (i.e. historical maps) |
| B | 10-50 | Historic changes can be assessed for the Earth observation era. |
| T | One time only (0) | Only current and potentially future data are available, but this is useful for those who require current status products, for example for modelling, and static assessments. |
| **Required Measurement Uncertainty** | % for accuracy and errors of omission and commission and hectares for area estimates incl. 95 % confidence intervals | Primary: overall map accuracy and errors of omission and commission for individual land cover categories and types of change (incl. confidence interval). Secondary: bias for area estimates (incl. confidence intervals) | G | 5 | For reporting purposes, this would allow sufficient accuracy, where all classes have high accuracies. An independent accuracy assessment using statistically robust, global or regional reference data of higher quality is required for any ECV land cover product. |
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| B | 15 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| T | 25 | Stability is important for long-term land cover datasets where multiple sensors are used to generate a time series dataset. High stability is required for assessing long-term trends. The stability can be assessed by multi-date independent accuracy assessment. The stability requirements are tighter that for overall uncertainty since the aim for multi-date ECV data is to provide information on changes and trends. |
| **Standards and References** |  | | | | |
| **Adaptation and Extremes** | | | | | |
|  | Relevant? (Yes/No) | Sugg. Req. sufficient? (Yes/No) | Explanation | | |
| **Adaptation[2]** | Yes | Not for all cases | Adaptation interventions per land cover can be planned, and changes in land cover can be seen as adaptation interventions in themselves (i.e. increased forest cover supports water cycling, reduces soil erosion and cools cities). One adaptation need will be to accommodate sea level rise and coastal erosion (which may be due to storm frequency so is relevant in the context of extremes), and this change from land mass to sea is relevant for land cover.  Largely, in that land cover specific interventions can be planned and land cover changes observed. High resolution land cover maps would be better suited (10-30 m and 5 year frequency). At present, land cover maps do not necessarily capture changes in boundaries between land and sea, as they may be produced with a fixed land surface mask. | | |
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### Comment 1

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| --- | --- |
| Author: ECMWF | Email: ecresgcosreqs@gmail.com |
| The data should be provided with the UN/FAO Land Cover Classification System (LCCS) + C3/C4 sub-classification  Cross-walking tables to other common classifications should also be provided. | |

### Comment 2

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| Author: Annett Bartsch | Email: Annett.Bartsch@polarresearch.at |
| Thematic content is indeed a crucial issue in the context of global landcover mapping and subsequent applications in the context of climate change. Currently used schemes for global mapping are not applicable in all regions. Further schemes should be considered to address specifically the needs in polar regions.  See e.g.:  Bartsch, A.; Höfler, A.; Kroisleitner, C.; Trofaier, A.M. Land Cover Mapping in Northern High Latitude Permafrost Regions with Satellite Data: Achievements and Remaining Challenges. Remote Sens. 2016, 8, 979. | |