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Deliverable 2.6

Assessment of ecosystem services of Figaredo Mine

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Executive Summary

Within this Deliverable, the assessment of ecosystem services of Figaredo Mine is developed.

In order to select the ecosystem services that can be considered representative for the Figaredo Mine case study area, the Common International Classification of Ecosystem Services (CICES) V5.1 was used as the reference for their study.

From this point and taking into consideration the ecosystem services selected by the most cited scientific literature in this field, as well as the CLC classes of the Figaredo Mine, the topography of the area and the climate conditions, five ecosystem services were considered as representative: food provision, climate regulation, carbon sequestration, water flow regulation and qualities of species or ecosystems.

Regulation of soil loss (by erosion or landslides) was not selected as an ecosystem service as in Asturias vegetation grows everywhere and quite quickly. Hence, erosion or soil loss is not a problem for the landscape.

From each ecosystem service selected, the following information was collected: CICES V5.1 class level, ecosystem service (ES) indicator, measuring method, scientific references, primary data sources, type of valuation and sources of uncertainty.

1 Introduction

Work Package Nº 2 focuses on mapping and assessing the ecosystems and their services of the project's case studies. Specific objectives are:

1. To identify the adequate boundaries of the different case studies based on existing spatial connectivity and functional cohesion for each coal mining-affected area.
2. To delineate, categorise and map the different ecosystems types of land covers in the study areas, according to CORINE Land Cover classes (Bossard, Feranec, & Otahel, 2000; Barbara, György, Gerard, & Stephan, 2017), although doing detailed field mapping at a higher resolution.
3. To assess the ecosystem services according to the Common International Classification of Ecosystem Services (CICES) V5.1 (Haines-Young & Potschin, 2018), in order to achieve standardisation and to avoid any overlapping or redundancy within the different categories.
4. To implement a geographic information system (GIS) web interface for each-case study, allowing constructing user desired information thematic maps for viewing purposes.

As the typology of ecosystems and ecosystem services will provide the analytical frame for the project, in order to operationalise this work package, after Task 2.1 that was focused on the baseline mapping of relevant ecosystems, Task 2.2 will focus on the assessment of ecosystem services.

In order to achieve the higher degree of standardisation and to avoid any overlapping or redundancy within the different categories, the hierarchical structure of the Common International Classification of Ecosystem Services (CICES) V5.1 will be used to assess the ecosystem services of each case study, that is "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment, 2005).

For each relevant land cover the three main section categories (provisioning services, regulating and maintenance services, and cultural services) will be considered, both biotic and abiotic, divided into main types of output or process (Division).

After that, the main types of output or process will be divided into group levels, according to the biological, physical or cultural type or process, and sub-divided into class categories, that are codified in CICES. Class types within class categories will allow to link ecosystem services with identifiable services, suggesting ways of measuring the associated ecosystem services output.

Deliverable 2.6 will undergo the assessment of ecosystem services of Figaredo Mine, property of HUNOSA (Spain).

2 Assessment of representative ecosystem services for Figaredo Mine

Figure 2-1 presents CORINE Land Cover classes in Figaredo Mine, and Figure 2-2 presents CLC classes in Figaredo Mine over the Orthoimage of the area.

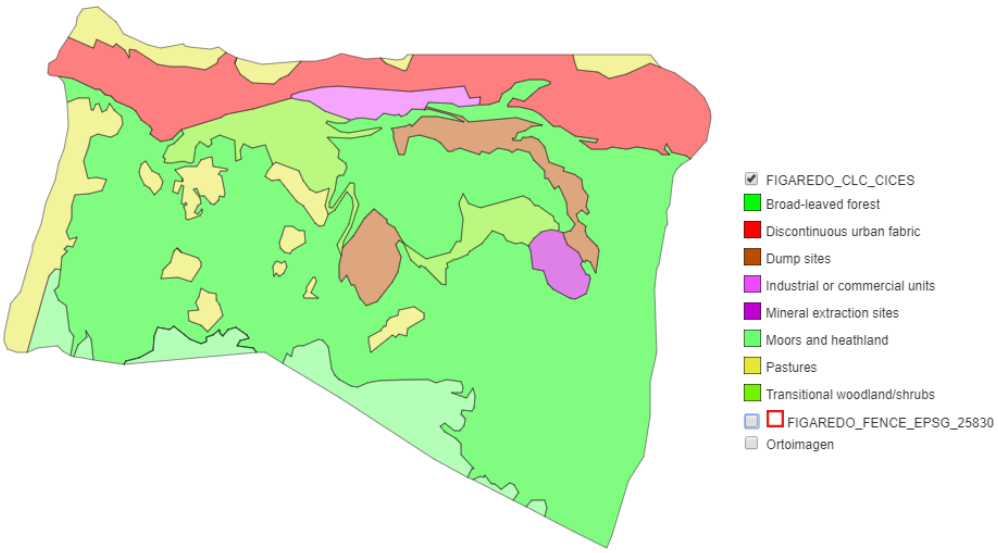

Figure 2-1. CORINE Land Cover classes in Figaredo Mine

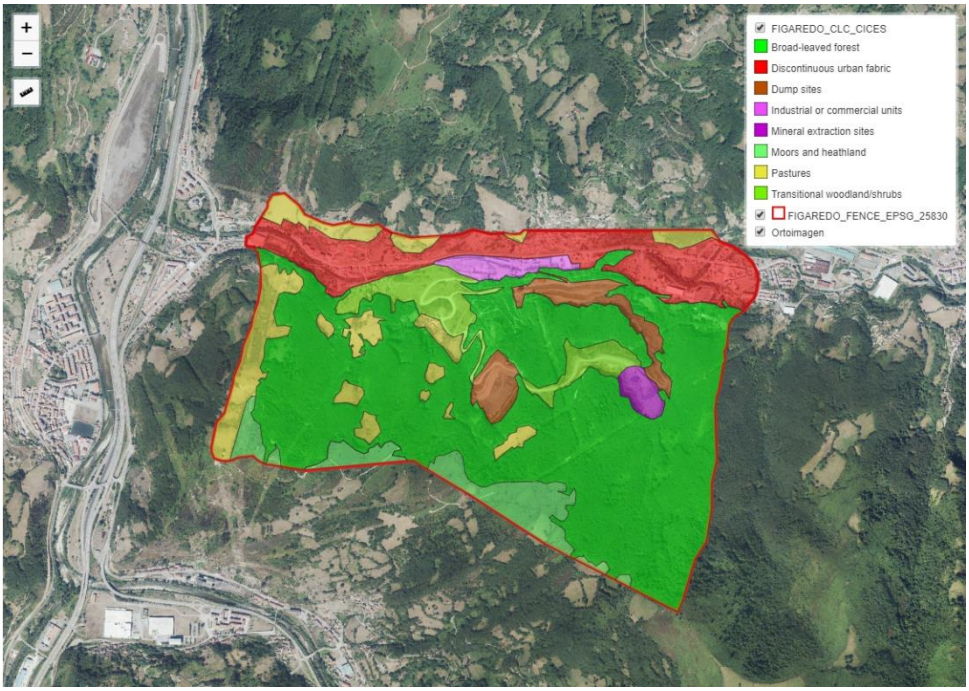

Figure 2-2. CLC classes in Figaredo Mine over the orthoimage of the area

Figure 2-3 presents a 3D image of the study area with the CLC classes over impressed.

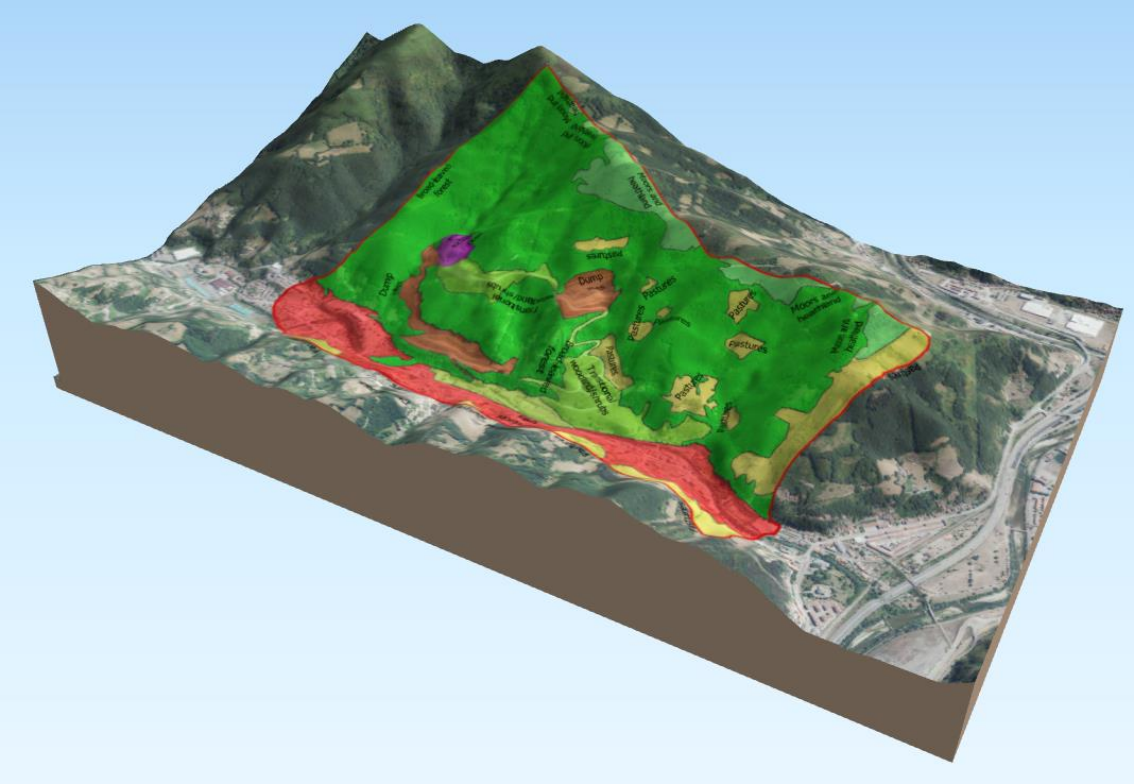

Figure 2-3. 3D image of the CLC classes

Figure 2-4 presents the spider graph of the CLC classes for Figaredo mine, with a strong projection over the forest and semi natural areas, something usual in Asturias region.

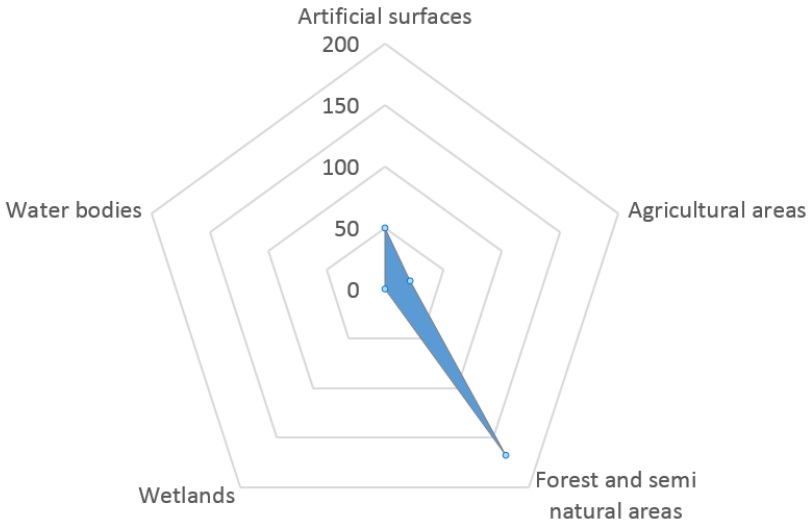

Figure 2-4. Spider graph of CLC classes for Figaredo mine (ha)

After analysing CLC classes of the study area, as well as the topography and the scientific literature in this field, the following ecosystem services (at the level of classes) were selected as important/representative for Figaredo mine, with indication of the CICES V5.1 code.

Regulation of soil loss (by erosion and/or land slides) was not selected as an ecosystem service as in Asturias vegetation grows everywhere and quite quickly, so erosion or soil loss are not a problem for the landscape.

The rest of ecosystem services that appear in the CICES V5.1 were not considered as representative or did not exist in the Figaredo Mine study area.

Of course, when alternative scenarios for future development will be studied, it may be necessary to increase the list of representative ecosystem services.

2.1 PROVISIONING SERVICES: FOOD PROVISION

Food provision is delivered in the Figaredo case-study only in Pastures. In Asturias, Pastures such as the ones in the Figaredo area are used to feed up mainly cows reared for nutritional purposes (to produce meat).

- Class level: 1.1.3.1 Animals reared for nutritional purposes.
- ES indicator: Livestock production.
- Method: Livestock units ha^{-1} $year^{-1}$.
- Reference: Baró, F., Gómez-Baggethun, E., & Haase, D. (2017). Ecosystem service bundles along the urban-rural gradient: Insights for landscape planning and management. Ecosystem Services, 24, 147–159. https://doi.org/10.1016/j.ecoser.2017.02.021
- Main data sources:
  - ✓ 2017 Census of Agriculture. United States Department of Agriculture. National Agricultural Statistics Service https://www.nass.usda.gov/AgCensus/
  - ✓ Spanish Ministry of Agriculture. Cow prices. https://www.mapa.gob.es/es/ganaderia/estadisticas/mercados_agricolas_ganaderos.aspx
- Valuation by direct methods (e.g. market prices).
- Sources of uncertainty:
  - ✓ Assessment: seasonal changes depending on weather conditions.
  - ✓ Valuation: changing market prices depending on demand /supply, elasticity of demand/supply, substitution, etc.

2.2 REGULATING SERVICES: CLIMATE REGULATION

Climate regulation is delivered in the Figaredo case-study by Broad-leaved forest, Moors and heathland, Transitional woodland/shrubs and Pastures.

- Class level: 2.2.6.2 Regulation of temperature and humidity, including ventilation and transpiration.
- ES indicator: Potential evapotranspiration ha^{-1}.
- Method: LST from Landsat Thermal and Surface Emissivity and fETP or water balance.
- References:
  - ✓ Schwarz, N., Bauer, A., & Haase, D. (2011). Assessing climate impacts of planning policies - An estimation for the urban region of Leipzig (Germany). Environmental Impact Assessment Review, 31(2), 97–111. https://doi.org/10.1016/j.eiar.2010.02.002
  - ✓ Haase D (2009) Effects of urbanisation on the water balance - A long-term trajectory. Environ Impact Assess Rev 29:211–219. https://doi.org/10.1016/j.eiar.2009.01.002
- Valuation by indirect methods (e.g. avoided damage cost, repair cost, replacement cost).
- Sources of uncertainty:
  - ✓ Assessment: Differing values in different climatic settings/conditions, Modelling assumptions (reduction of complexity at expense of exactness)
  - ✓ Valuation: Valuation is based on effects of lack of regulating service (assumptions of transformation, reduction of complexity of cause-effect relationships)

2.3 REGULATING SERVICES: CARBON SEQUESTRATION

Carbon sequestration is delivered in the Figaredo study-case by Broad-leaved forest, Moors and heathland & Transitional woodland/shrubs. Pastures are not included here as they are consider a Provisioning service, thus being incompatible with carbon sequestration.

- Class level: 2.2.6.1 Regulation of chemical composition of atmosphere and oceans.
- ES indicator: Above-ground carbon storage ha^{-1}.
- Method: Above-ground carbon storage linked to land use [MgC/ha].
- Reference: Strohbach, M. W., & Haase, D. (2012). Above-ground carbon storage by urban trees in Leipzig, Germany: Analysis of patterns in a European city. Landscape and Urban Planning, 104(1), 95–104. https://doi.org/10.1016/j.landurbplan.2011.10.001

- Main data sources:
  - ✓ Liski, J., Lehtonen, A., Palosuo, T., Peltoniemi, M., Eggers, T., Muukkonen, P., & Mäkipää, R. (2006). Carbon accumulation in Finland's forests 1922-2004 - An estimate obtained by combination of forest inventory data with modelling of biomass, litter and soil. Annals of Forest Science, 63(7), 687–697. https://doi.org/10.1051/forest:2006049
  - ✓ EU Emissions Trading System (EU ETS). https://ec.europa.eu/clima/policies/ets_en
- Valuation by indirect methods (e.g. avoided damage cost, repair cost, replacement cost).
- Sources of uncertainty:
  - ✓ Assessment: Differing values in different climatic settings/conditions, Modelling assumptions (reduction of complexity at expense of exactness)
  - ✓ Valuation: Valuation is based on effects of lack of regulating service (assumptions of transformation, reduction of complexity of cause-effect relationships)

Figure 2-5 presents the ES delivery of Carbon sequestration based only on a reference scale, not on the ES indicator, as this will be delivered at a later stage of the project.

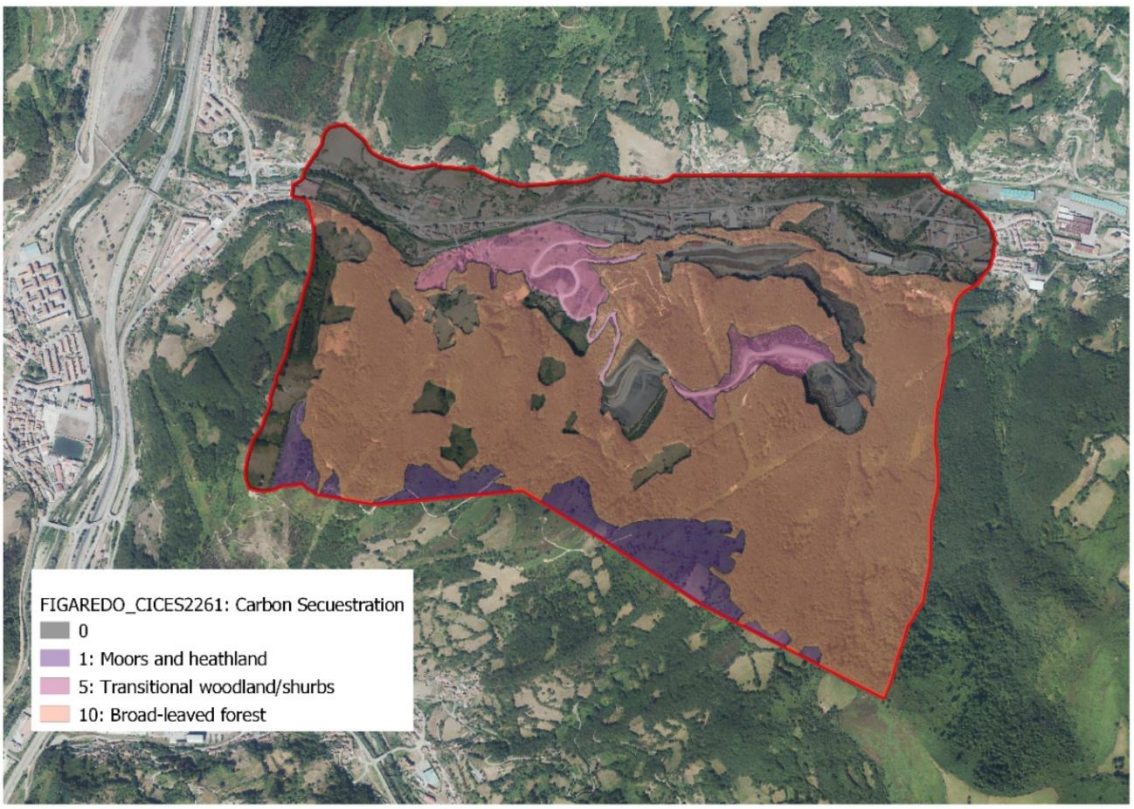

Figure 2-5. Regulating services: Carbon sequestration

2.4 REGULATING SERVICES: WATER FLOW REGULATION

Water flow regulation is delivered in the Figaredo study-case by Broad-leaved forest, Moors and heathland, Transitional woodland/shrubs & Pastures.

- Class level: 2.2.1.3 Hydrological cycle and water flow regulation.
- ES indicator: Volume of water retained by vegetation ha^{-1}.
- Method: Water balance.
- Reference: Haase D (2009) Effects of urbanisation on the water balance - A long-term trajectory. Environ Impact Assess Rev 29:211–219. https://doi.org/10.1016/j.eiar.2009.01.002
- Valuation by indirect methods (e.g. avoided damage cost, repair cost, replacement cost).
- Sources of uncertainty:
  - ✓ Assessment: Differing values in different climatic settings/conditions, Modelling assumptions (reduction of complexity at expense of exactness)
  - ✓ Valuation: Valuation is based on effects of lack of regulating service (assumptions of transformation, reduction of complexity of cause-effect relationships)

2.5 CULTURAL SERVICES: QUALITIES OF SPECIES OR ECOSYSTEMS

The biophysical characteristics or qualities of species or ecosystems (landscapes) which people seek to preserve for future generations for whatever reason: in this case the reconstruction of a typical Asturian forest, with oaks as the representative vegetation and Brown bear and Cantabrian capercaillie as representative fauna can be an interesting option for the future.

- Class level: 3.2.2.1 Characteristics or features of living systems that have an existence value.
- ES indicator: Number of visitants.
- Method: Number of visitants $year^{-1}$.
- Reference: Baró, F., Palomo, I., Zulian, G., Vizcaino, P., Haase, D., & Gómez-Baggethun, E. (2016). Mapping ecosystem service capacity, flow and demand for landscape and urban planning: A case study in the Barcelona metropolitan region. Land Use Policy, 57, 405–417. https://doi.org/10.1016/j.landusepol.2016.06.006
- Main data sources:
  - ✓ Reserva Natural Integral de Muniellos. http://www.fuentesdelnarcea.org/asturias/el-paraiso-mas-natural/reserva-natural-integral-de-muniellos_16_10_18_0_1_in.html
- Valuation by indirect methods (e.g. stated or revealed preference, etc.).
- Sources of uncertainty:
  - ✓ Assessment: definition of ES is closely connected to cultural values.
  - ✓ Valuation: Valuation is based on cultural values, which are to certain, extend subjective, and based on the cultural background of the stakeholders.

3 Conclusions and lessons learnt

For the assessment of ecosystem services for Figaredo Mine, identified environmental impacts were analysed. Five ecosystem services for Figaredo Mine were selected, i.e. three regulating, one cultural and one provisioning. Control of erosion was not considered, as in Asturias, the vegetation grows so fast that erosion is not a problem unless the slopes are too steep. Cultural services were considered an exciting option for the future, as nowadays, there is no such ecosystem service.

Figaredo Mine will be significantly impacted by mining activity negatively influencing ecosystem services output, i.e. negative impact on biodiversity. On the other hand, a response on the impact can increase the potential of different services that in non-mining areas would be limited or event not possible.

Figaredo Mines waste heap is in the first step of being re-exploited. Thus, it is an excellent opportunity to evaluate the initial pre-mining state (almost) and the post-mining state. It will be possible to consider all the process and the different improvements in the ecosystem services provision to have a perfect perspective of the whole restoration process.

Concerning the interrelation between ecosystem services in mining-impacted areas, it is essential to note that different restoration or rehabilitation scenarios could generate new potential of ecosystems to provide high quality services. The ecosystem services concept and their assessment will be applied to different restoration activities and future redevelopment scenarios for the case study landscape. This approach will allow comparing scenarios in terms of the potential to provide the most favourable ecosystem services.

The lessons relevant to RECOVERY from the assessment of ecosystem services of Figaredo Mine can be summarised as follows:

1. The Common International Classification of Ecosystem Services (CICES) V5.1 is an excellent tool to be used as the reference for this kind of studies. Its hierarchical structure for assessing ecosystem services, which the European Environment Agency developed, ensures that cross-reference can be made.
2. The CLC classes of the study area and the topography and the scientific literature in this field allow an excellent selection of representative ecosystem services.
3. According to the scientific literature and discussions among the project's partners, a number between 5 and 10 ecosystem services was considered adequate for every specific area's description.
4. The search for primary data sources about the different ecosystem services may pose big handicaps as, for example, carbon sequestration in forests is not studied in every ecosystem around Europe.

5. The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations (TEEB, 2010) is also an excellent tool for selecting valuation methods.
6. The lack of direct data sources can be the solution by means of introducing different sources of uncertainty in the selected valuation methods.

4 Glossary

CICES - Common International Classification of Ecosystem Services

CLC - CORINE Land Cover

CORINE - Coordination of information on the environment

EEA - European Environment Agency

ES – Ecosystem Service

GIS - Geographic information system

HUNOSA - Hulleras del Norte S.A.

SEEA - System of Environmental and Economic Accounting

UNIOVI - University of Oviedo

UNSD - United Nations Statistical Division

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