

Ulmus - elms in Europe: distribution, habitat, usage and threats

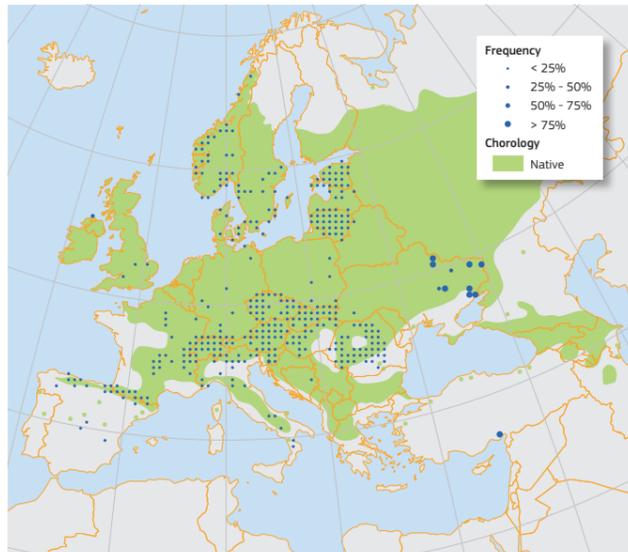
G. Caudullo, D. de Rigo

Among elm tree species, prevalently concentrated in the temperate regions of the northern hemisphere, three species are present in Europe with a wide range and native to most countries: the European white elm (*Ulmus laevis* Pall.) which has a more southern range, the wych elm (*Ulmus glabra* Huds.) which has a more northern range, and the field elm (*Ulmus minor* Mill.) which has a more eastern range. Elms are deciduous medium-sized trees, characterised by pollination and seed dispersal driven by the wind. They all are components of mixed broadleaved cool forests, distributed principally near rivers and floodplains. These tree species have always played an important cultural role, being part of the traditional rural landscape as a tree of multiple purposes, such as working and firewood, fodder supplier, living grapevine support and more recently as an ornamental and roadside tree. The introduction into Europe in the last century of the fungal pathogen *Ophiostoma*, causing the Dutch elm disease, has devastated the elm populations throughout Europe with two destructive epidemics. Despite their drastic reduction, elms are not considered endangered species, as the main losses regarded mature cultivated trees in urban areas and countryside. Breeding programmes have selected hybrids resistant to Dutch elm disease for ornamental purposes, while in natural forests elms are less susceptible to this pathogen and more threatened by habitat reduction and water regulation.



Wych elm (*U. glabra*) is the tallest among European elms, reaching 40m in height. (Copyright Stefano Zerauscheck, www.flickr.com: AP)

The elms are deciduous medium-sized trees, growing from 20m (*Ulmus minor*) up to 40m (*Ulmus glabra*). The crown can vary much in shape: it is generally open, broad, billowing, from domed to cylindrical, but also conic. The bark is brownish-grey, deeply furrowed, smooth when young only in *U. glabra*. The leaves also vary greatly in dimension and form. They are alternate, dark green, usually asymmetrical at the base and acuminate at the apex, with toothed margins, from 4-10cm long in *U. minor* to 10-18cm long in *U. glabra*, smooth and downy above in *Ulmus laevis* and with black glands along leaf veins in *U. minor*. In autumn *U. laevis* sheds its leaves earlier than the other two species. Elms are **monoecious hermaphrodite** species: the flowers appear before the leaves in early spring, arranged in clusters of 10-30 elements, with 20mm long stems in *U. laevis*, while close to the



Map 1-A: Plot distribution and simplified chorology map for *Ulmus glabra*. Frequency of *Ulmus glabra* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *U. glabra* is derived after several sources^{16, 17, 46-49}.

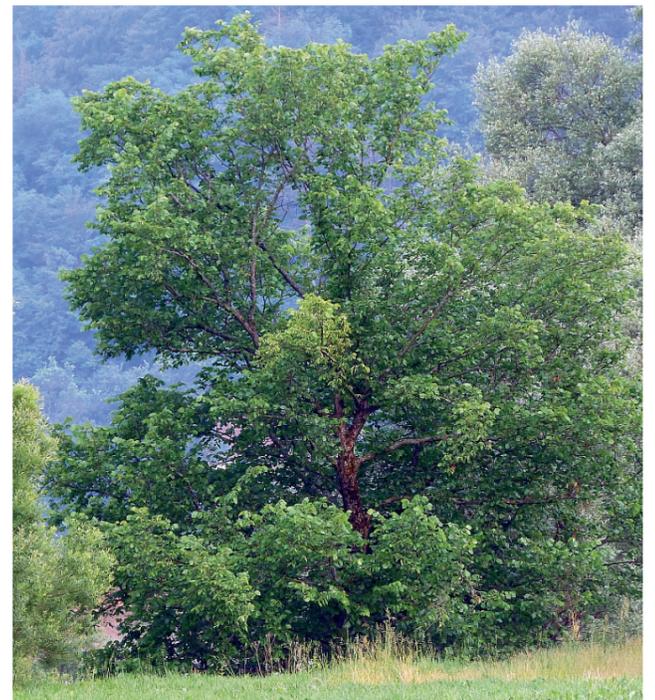
shoot in *U. glabra* and *U. minor*. The wind pollinated flower is bell-shaped, without petals, and dark purplish-red to brownish. The fruits are ovate **samaras**, with a single central nut seed rounded by a membrane, which may have a hair-fringed margin in *U. laevis*, 2-3 cm, maturing in late spring¹¹⁻¹³.

Distribution

The three European elms all have a widespread range, and are native to most European countries. *U. glabra* has a more northerly distribution than the others, occurring in Norway up to the Arctic Circle and only on mountain areas in its southern range, extending east to the Urals. *U. minor* thrives better in southern Europe, reaching at its northernmost extent the Baltic Sea. Southwards it can be found up to Algeria, Israel and North-eastern Iran. *U. laevis* has a more eastern distribution, from central France to the Ural Mountains. It ranges from South Finland on north, to its southernmost limits in Bulgaria and Crimea^{8, 14-17}.

Habitat and Ecology

The European elms are a component of cool mixed broadleaved forests, showing a clear preference for water- and nutrient-rich soils, distributed principally near rivers and streams or on floodplains¹⁸. *U. glabra* is adapted to hemiboreal and temperate forests with cool summers. It is a more demanding species, thriving in moist forests with rich soils and high humidity, or in groves along streams, but rarely in very wet or flooded areas^{19, 20}. It does not tolerate basic soils, growing better on mildly acid soils up to pH 4.7²¹. It occurs in mixed forests with



White elm (*U. laevis*) is a riparian tree growing principally along rivers. (Copyright Stefano Zerauscheck, www.flickr.com: AP)

other broadleaved species, often associated with noble trees such as ashes (*Fraxinus* spp.), maples (*Acer* spp.) and limes (*Tilia* spp.), and locally more abundant in optimal sites²²⁻²⁴. *U. laevis* occurs in riparian forests along large rivers such as the Rhine, the Elbe and the Danube, at altitudes of less than 300 m, thriving in damp, periodically flooded, soils^{6, 25}. Despite being typically found in moist sites, it can tolerate moderately dry and deep soils, preferring slightly acid and siliceous soils. The hairs on the samaras increase their ability to float by surface tension, favouring long-distance dispersal by water^{18, 26, 27}. In forest stands, it is a dominated species of mixed alluvial forests, rarely reaching heights of 35 m, occurring with pedunculate oak (*Quercus robur*), ashes (*Fraxinus* spp.), alders (*Alnus* spp.) and along with willows (*Salix* spp.) and poplars (*Populus* spp.) in more flooded and disturbed sites²⁴. *U. minor*, like *U. laevis*, is a riparian tree. It occurs in Mediterranean regions along banks of relatively small streams. In central Europe it is a prominent component of woods along major rivers together with *U. laevis*, while in southern Russia and the north-east Balkans it is a component of wooded steppes⁴. Unlike other elms, it is more of a pioneer species, characterised by being light-demanding and fast-growing. It also tolerates different stresses well, such as waterlogging or drought, pollution and salty winds^{19, 28}. It has a strong ability to reproduce rapidly by root suckers, even at several metres of distance, forming connections between root systems, so it is often found in groups at the forest edge, seldom as pure stands²⁹. Like *U. laevis*, *U. minor* grows in floodplain broadleaved communities with pedunculate oak (*Quercus robur*) and with ashes (*Fraxinus* spp.) in less frequently flooded sites^{22, 24, 30}. Adults of both riparian elms show a higher tolerance to inundation than common ash (*Fraxinus excelsior*), but less than white willow (*Salix alba*)³¹.



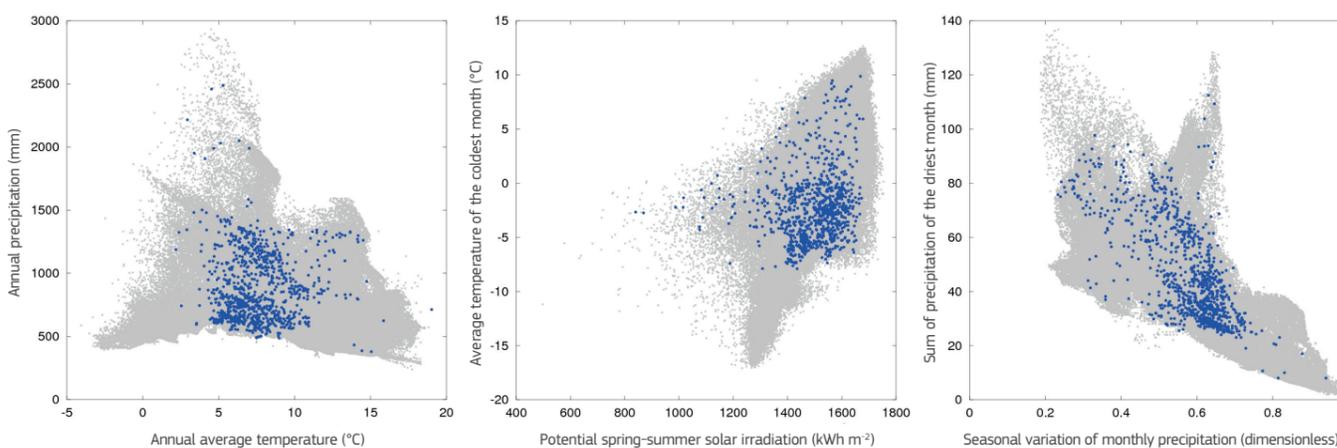
Elm leaves have acuminate apex, toothed margins and are asymmetrical at the base; those of wych elm (*U. glabra*) are the largest, reaching 18cm in length. (Forestry Commission, www.forestry.gov.uk © Crown Copyright)

Importance and Usage

For centuries elms have played an important cultural role in rural areas, being part of the traditional landscape as a tree of multiple uses³². From a commercial point of view, elms are a

Field data in Europe (including absences) ● Observed presences in Europe ●

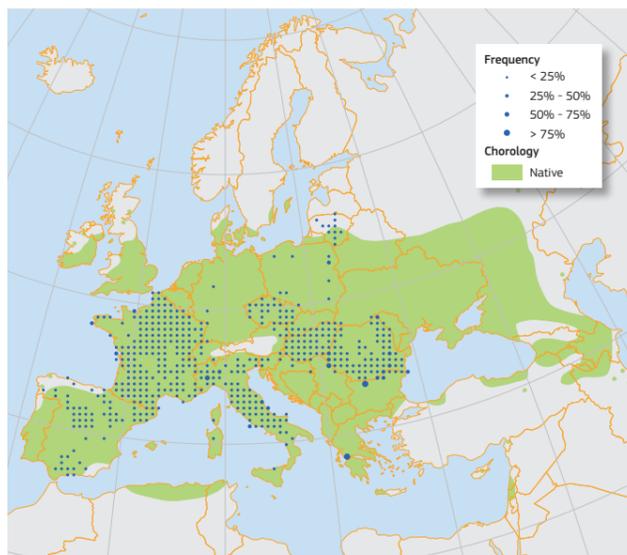
Autoecology diagrams based on harmonised field observations from forest plots for *Ulmus glabra*.



source of good-quality wood, easy to work and used for furniture, flooring and as firewood, except *U. laevis*, which has a lower density and cross-grained wood, which causes difficulty in machine cutting and defects^{25, 29}. It has also an exceptional resistance to water decay, so that timbers are used as underwater piles, in shipbuilding and for water pipes^{28, 29}. *U. glabra* grows at relatively high altitudes and also in European boreal areas. The European mountainous areas are associated with soil erosion rates higher than the average. As this phenomenon is particularly serious in the boreal mountain system³³, *U. glabra* contributes to provide a valuable service in watershed protection and soil stabilisation³⁴. Given the suitability for elms to live in high humidity areas, all the European elms may help to mitigate soil erosion by water even where particularly frequent or intense precipitation patterns are observed, and along riparian areas. In the Mediterranean regions since ancient Greek times, *U. minor* was traditionally used as



Seed germination of the field elm (*U. minor*).
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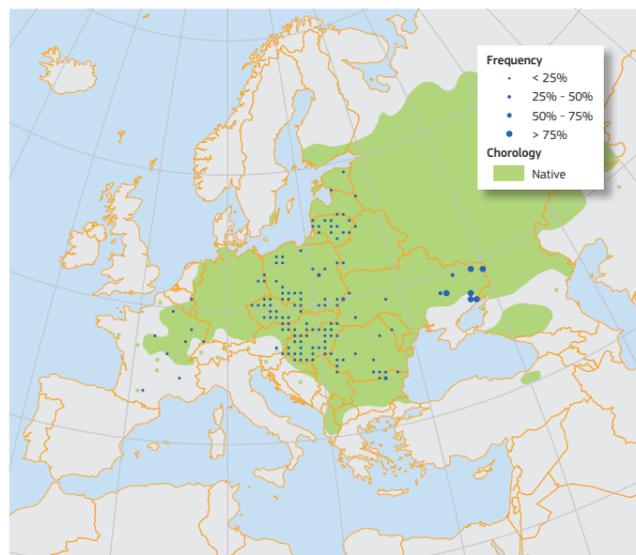


Map 1-C: Plot distribution and simplified chorology map for *Ulmus minor*. Frequency of *Ulmus minor* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *U. minor* is derived after several sources^{15, 16, 47, 48, 51}.

living support for grapevines, also providing fodder in summer and small-wood and poles when coppiced. This practice was then exported by the Romans to the whole of Europe³⁵. In fact, thanks to its fast-growing, re-sprouting ability and easy propagation by suckering, *U. minor* has been widely propagated and planted in the countryside and more recently on roadsides and in urban areas⁶. However, the pandemics of the vascular Dutch elm disease starting in the last century devastated the elm populations in the whole of Europe, making it necessary to substitute it with other tree species or with other Dutch elm disease-resistant elms, such as Siberian elm and its hybrids³⁶.

Taxonomy of elms

The genus *Ulmus* includes 20-40 species prevalently in the temperate regions of the northern hemisphere and concentrated mostly in Eurasia¹. The ambiguity in number of species results from the difficulty in their classification, which is very complex and is still under debate. In fact elms have a strong intra-specific variability in morphological traits, not only geographically, but even in the same tree during growing stages as a response to environmental conditions. Moreover, they have an extensive natural hybridisation capacity between them². With the use of chloroplast DNA, a simplified classification of European elms has been proposed. It counts three 'large' species belonging to two sections, which comprise different varieties and subspecies historically described^{3, 4}. *Ulmus laevis* Pall. (European white elm) belonging to the *Blepharocarpus* section, *Ulmus glabra* Huds. (wych elm) and *Ulmus minor* Mill. (field elm) belonging to the *Ulmus* section. *U. minor* can be defined as a complex of species, sometimes described on the basis of morphological traits and geographical distribution as separated species: i.e. Plot's Elm (*Ulmus plotii*), the English elm (*Ulmus minor* var. *vulgaris* syn. *Ulmus procera*) and the grey elm (*Ulmus minor* subsp. *canescens* syn. *Ulmus canescens*)^{5, 6}. *U. glabra* has a strong latitudinal variations and two subspecies have been proposed: *U. glabra* subsp. *glabra* in the southern range and *U. glabra* subsp. *montana* in the northern range. A variety is also recognised in Caucasus (*U. glabra* var. *trautvetteri*), which is sometimes treated as a separate species (*Ulmus elliptica*)^{7, 8}. The variety *Ulmus laevis* var. *celtidea* syn. *Ulmus celtidea* is an endemic elm native of northern Ukraine, which differs morphologically from *U. laevis*^{9, 10}. Finally *U. glabra* and *U. minor* can naturally hybridise in intermediate forms, commonly referred to as *Ulmus x hollandica* (Dutch elm), and both hybridise with *Ulmus pumila* (Siberian elm), recently introduced from Asia.



Map 1-B: Plot distribution and simplified chorology map for *Ulmus laevis*. Frequency of *Ulmus laevis* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *U. laevis* is derived after several sources^{16, 46, 50}.



Field elm (*U. minor*) seeds are circular samaras with the nut in the middle.
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Threats and Diseases

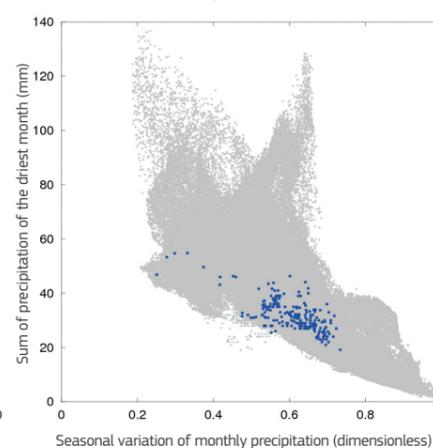
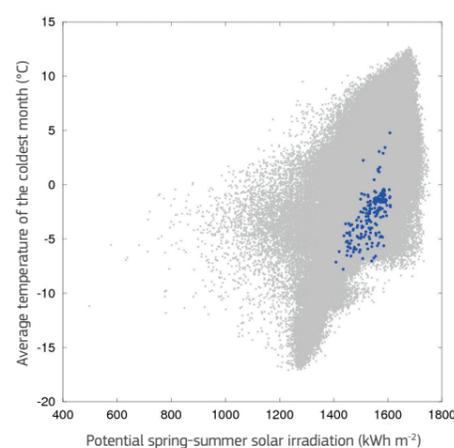
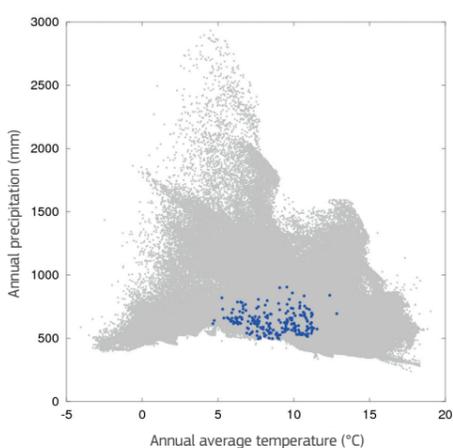
The story of the elms is marked by the two destructive epidemics, caused by the introduction of hyper-virulent fungal pathogens, *Ophiostoma ulmi* in the 1920s and *Ophiostoma novo-ulmi* in 1970s, usually called Dutch elm disease (DED). It is considered one of the most significant tree diseases known in the world, having devastated the elm populations throughout Europe and North America³⁷. DED is very aggressive and is transmitted by the bark beetles of genus *Scolytus* or throughout root connections, attacking principally mature *U. minor* leading to death in 2-3 years³⁸. *U. glabra* is susceptible to the fungal agent, but remains unaffected at higher latitudes, where the insect vector cannot survive. *U. laevis* is susceptible, but less attractive for the bark beetles, so its population was not severely damaged by the DED, except in the western ranges⁵. Several strategies have been adopted in an attempt to prevent infection and reduce the impacts of DED. The chemical and biological controls against the pathogen or the insect vector encountered many limits, due to poor results or high costs when utilized at large scales³⁹. Two breeding programs arose in Netherlands and in Italy after the pandemics, having a success for selecting cultivars resistant to DED with the use of Asian parental materials. Most of those hybrids were planted in substitution of garden elms^{38, 40}. However, the widespread use of cultivars has increased the risk of 'genetic pollution', mainly when planted in the countryside near to natural forests⁶. Despite their drastic reduction during the last century, the European elm species (in a narrow sense) can be considered not actually in danger. The main losses regarded introduced and cultivated plants in urban areas and countryside with relatively poor genetic variability⁶. Concerning elms in forest habitats, although larger trees are heavily affected by DED, in the United Kingdom and southern Sweden there has been reported significant resilience of a fast turnover population of poles in the understorey^{41, 42}. Particular attention in conservation has been also given to small and marginal populations at the borders of their natural distributions, with the aim of minimising the risk of genetic loss. Among the European elms, *U. laevis* is the less susceptible to DED. However, its populations are often in small and fragmented stands as a result of the reduction of the riparian forests, caused by water-basin regulation and demand for agricultural lands. Potentially, genetic drift as a result of



Galleries of *Scolytus* beetle on a wych elm (*U. glabra*).
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Field data in Europe (including absences) ● Observed presences in Europe ●

Autoecology diagrams based on harmonised field observations from forest plots for *Ulmus laevis*.



landscape changes along large rivers could represent a more serious risk than DED⁶.

Aside from this serious disease, elms are susceptible to the Asian longhorned beetle (*Anoplophora glabripennis*). *A. glabripennis* can also attack several other trees, such as several species of maple (*Acer* spp.), poplar (*Populus* spp.) and birch (*Betula* spp.), whose distribution partially overlap with that of elms⁴³⁻⁴⁵.



Seedling of field elm (*U. minor*).
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Field elm (*U. minor*) isolated tree in rural area. This elm rarely exceeds 20 m in height.
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Flowers of white elm (*U. laevis*) are clustered on long stems.
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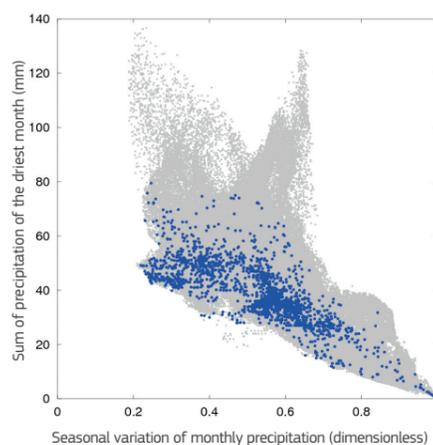
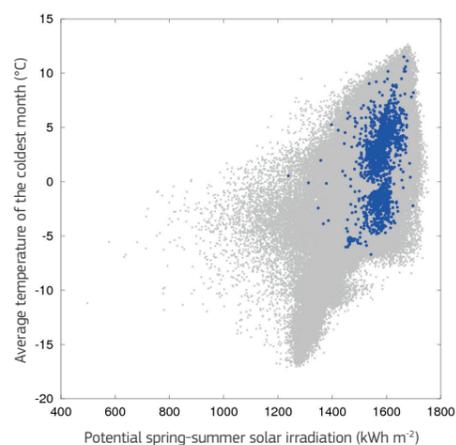
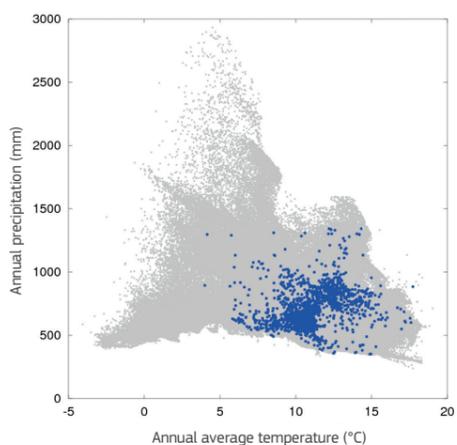
Wych elm (*U. glabra*) seeds mature in late spring.
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Field data in Europe (including absences) ● Observed presences in Europe ●

Autoecology diagrams based on harmonised field observations from forest plots for *Ulmus minor*.



This is an extended summary of the chapter. The full version of this chapter (revised and peer-reviewed) will be published online at <https://w3id.org/mtv/FISE-Comm/v01/e01bd40>. The purpose of this summary is to provide an accessible dissemination of the related main topics.

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