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Interreg Alpine Space project - **NEWFOR**

Project number 2-3-2-FR

NEW technologies for a better mountain **FOR**est timber mobilization

Priority axis 2 - Accessibility and Connectivity

Workpackage 8: Logistical Planning Strategy

Requirements catalogue for transportation infrastructure in relation to mobilisation of forest resources

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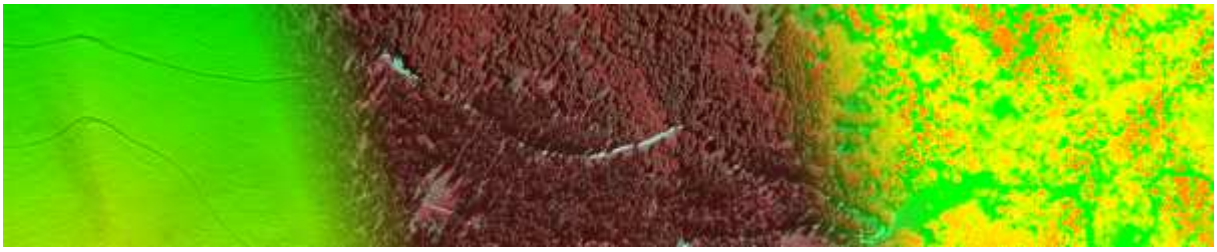
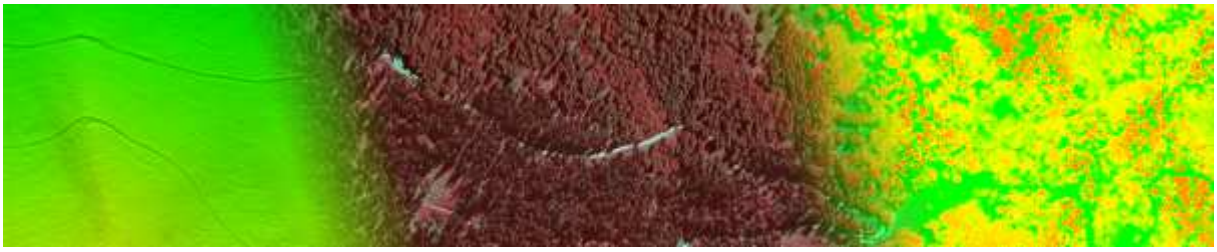
Final version 30/11/2014



The consortium of the project Interreg Alpine Space NEWFOR

This project has been, co-funded by the European Regional Development Funds, and achieved under the third call of the European Territorial Cooperation Alpine Space Programme 2007-2013.



CONTENT

1 ABSTRACT

In this reports forest road requirements in the different Alpine Space countries are presented. The basics for a proper management of the transportation infrastructure is the definition and classification of road. The great variability present among the countries of the Alpine space needs a detailed dissertation. Not only on a national level, indeed, the definition acquires local adaptations to specific regional needs. Furthermore, the detail level itself reached from the single laws changes quite sensibly. It is therefore crucial to develop an harmonized classification and regulation in the context of a global and international organization of the wood transportation system.

2 A SYNTHETIC OVERVIEW OF THE INTERREG ALPINE SPACE PROJECT NEWFOR

2.1 THE CONTEXT

Although forests represent a key resource of mountain environments, their valorisation is hampered by accessibility constraints that prevent an efficient mapping, management, harvesting and transport of wood products.

Forests fulfil multiple functions in mountainous areas. They have an ecological function as host of many habitats and species. They also are a leisure area for social activities such as hiking, skiing… From the economical perspective, the production of renewable resources like timber and fuelwood has positive effects both at global scale, with climate change mitigation, and at local scale with rural employment and the development of a regional value chain. The objective of preserving and improving the development of mountain forests is a point of public interest. However, managing forests in mountain territories is a difficult task as topography and climate set strong constraints inside a complex socio-economical framework.

In particular, a precise mapping of forest biomass characteristics and mobilization conditions (harvesting and accessibility) is a prerequisite for the implementation of an efficient supply chain for the wood industry. The available information is currently insufficient to provide, at reasonable costs, the required guarantees on the wood supply and on its sustainability. With the recent development of new remote sensing technologies and modelling tools, major improvements regarding the evaluation of the forest growing stock and accessibility are now possible. Upon this highly valuable information, decision-making tools must be build to optimize the investments in forest infrastructures required for a cost-effective wood supply while securing the sustainable management of forests, and to support the implementation of an efficient European policy for mountain forest management.

2.2 OBJECTIVES OF THE PROJECT

According to this context and based on the use of new technologies (LiDAR: light detection and ranging, Unmanned Aerial Vehicle,...) for forest and topography characterization, the project NEWFOR is dedicated to enhance and develop tools and adapted policies for decision making in the field of a sustainable and adaptive mountain forest resources management facing the sustainability of mountain forest ecosystems services.

So, the main objective of the NEWFOR project is the improvement of mountain forest accessibility for a better economical efficiency of wood harvesting and transport in a context of sustainable forest management and wood industry in changing climate.

The 14 partners involved in the project consortium tackle this objective within five thematic workpackages (WP):

- Forest resources and LiDAR

Recent developments in LiDAR technology, combined to other available data sources (aerial photographs, aerial photo series by UAVs, etc), are now allowing a precise and fine mountain forest resource quantification, qualification and mapping. Integrating this technology will provide an innovative response to the challenges of a precise and robust knowledge on the available growing stocks. The project aims at testing (e.g. benchmarks) and developing tools that will help forestry end-users to benefit from this technological advance.

- Forest accessibility

After the identification of forest resources, the second step of an efficient forest management is to evaluate the accessibility to these resources. In mountain areas, topography is the main constraint to a technical and economically efficient exploitation. The project demonstrated how to use topographic LiDAR data coupled with geographic information systems (GIS) for an optimal planning of forest harvesting and logging while taking current and scheduled accessibility of forest resources into account.

- Forest and industry connectivity

Once the forest resources and accessibility are characterized, then remains the issue of the connectivity between wood piles in the forests and wood yard of mills. This link is often neglected but is crucial for a comprehensive assessment of the wood supply efficiency.

- Costs and benefits evaluation

NEWFOR aims at developing decision-making tools dedicated to the definition of strategies for sustainable mountain wood supply chain. To fulfil this objective, tools for identifying forest resources, their accessibility and connectivity to the wood market are first considered separately. In order to achieve the demarche, and to choose the optimal strategy, it is necessary to evaluate the whole workflow from the economical aspect by comparing the costs and benefits of each possible strategy.

- Logistical planning strategy

There is a need to frequently adjust the planning of forest management to new economical evidence as well as to unforeseeable developments. Such an adaptive management needs to balance ecological, social and economic factors. The final objective was to provide forest managers and decision makers with reliable information for the evaluation of technical and economical conditions for their decision-making on timber supply chain logistical planning and land use strategies.

3 STATE OF THE ART OF THE TRANSPORTATION INFRASTRUCTURE MANAGEMENT IN THE ALPINE SPACE

3.1 AN OVERVIEW OF WOOD TRANSPORT ENTERPRISES

In most of the Alpine countries, transport enterprises which are usually independent from the timber industry own from 1 to 5 trucks. However, in Austria and especially in Slovenia, companies who have 5 to 20 trucks are more common. These small operators often operate at a very local scale (150 km of radius). It is also important to notice that these companies, because of their specific road materials, are exclusively specialized in the transport of round wood and cannot carry other goods.

Fleet composition itself differs greatly across the Alpine countries. In most cases, two factors determine the choice of the vehicles: the topographic conditions and the industrial demand.

That's why in Slovenia and in Austria, where most of the round wood is bought in short logs (4 to 5 meters), most of the fleet is composed of 3 axle trucks with 2 axle trailers. The main advantage of this system in the Alps, where forest roads are often steep and narrow, is represented by the following: (i) the truck can move with the trailer as long as the road allows it, (ii) it can leave the trailer on a timber yard in the forest, (iii) move to the forest site where the timber is prepared and perform loading operations, (iv) move back to the timber yard, (v) load the trailer with the crane, (vi) get the load for the truck at the forest site and move with the trailer to the sawmill. Such organization allows transport companies better access forest sites even at further distance from the roadside.

In France, the fleet composition is completely different, timber lorries are made of a tractor and a dolly. This method allows French transport companies to haul logs up to 21 meters, and to have a lower empty weight. Again, this choice depends on the sawmill supply chain methods and also on the harvesting system. In Slovenia some of the transport is also made with long logs, but semitrailers are used.

In terms of regulations: the payload is an important factor of competitiveness of the supply chain. For 5 and 6-axles truck the authorized payload is 44 tons except 40 tons in Slovenia. In France, the maximum payload can reach 48 tons and 57 tons on specific roads respectively for 5-axle and 6-axle trucks.

3.1.1 ORGANISATION

Most often, the planning of roundwood transport is made by the wood processing industries or units:

- Large sawmills, pulp mills and chipboard factories are giving a monthly planning (with also decade or weekly indications) to their wood procurement companies. They have developed an efficient logistic to optimize the timber supply according to their daily demand. The purpose is also to reduce storage space and idle time for transport companies.
- Small sawmills give transport instructions in a more erratic way…when they need roundwood in their timber-yard. Sometimes they still have their own harvesting and transport means (equipment's and human resources).

3.2 LEGISLATION AND INFRASTRUCTURE CLASSIFICATION

Many are the differences for what concerns the basics for a proper management of the transportation infrastructure: the definition of "road".

The great variability present among the countries of the Alpine space needs a detailed dissertation. Not only on a national level, indeed, the definition acquires local adaptations to specific regional needs. Furthermore, the detail level itself reached from the single laws changes quite sensibly.

3.2.1 AUSTRIA

The Austrian federal forest law (Forstgesetz, 1975) defines overall standards for forest roads in all regions.

According to the it, forest roads have to be planned, constructed and maintained in a way, that forest ecosystems are not affected more than necessary. In detail, forest roads must not:

a) Cause hazardous erosion
b) Affect the run off in torrents negatively
c) Influence the formation of avalanches and their impact
d) Disturb the stability in landslide areas

Planning and site supervision of forest roads can only be done by graduate engineers in forestry.

Forest roads have to be homologated by the administration of the district. In the course of this procedure the technical attributes of the forest roads are defined. The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management has defined a guideline (see Table below) for the construction of forest roads, which is used by the district administration.

Forest roads								
Class	**Driving conditions**		**Min. width[3] (m)**	**Steepness (%)**			**Curvature radius (m)**	**Infrastructural works (walls, ditches, etc.)**
				Main	**Maximum**			
	Vehicles	**Load (tons)**			**Natural surface**	**Improved surface**		
	Trucks	11.5[1] 20[2]	3.5-4 (3.3)	<12		14	8 (without widening)	
	Truck with trailer	11.5[1] 20[2]	3.5-4 (3.3)	<12		14	12.5 (with widening)	
	Trucks (limited trafficab.)	-	3.3	-	-	16	-	
	Tractors	-	3 (2.8)	3-20 (25)		25	-	
	Small vehicles							
Forest tracks								
-	Forestry vehicles	-	-	-	-	-	-	N

Lesser roads								
"Mule roads"	Mainly pedestrian	-	1.2	-	-	25	-	Y
Path	Pedestrian	-	Max. 1,2	-	-	100 (if stairs)	-	Y
Alpine itinerary	Pedestrian	-	-	-	-	-	-	N

[1] single-axle

[2] twin-axle

[3] width is meant for the only carriageway; 0.5 m should be added by each side for minimum full road width.

3.2.2 FRANCE

The French situation can be summarized as follows:

Property	***Typology***	***Relative legislation***
Public	Highway	Code de la Route
	National road	
	Department road	
	Municipal road	
Hybrid status	Rural road ("chemin rural")	
Private	Forest road ("chemin d'exploitation", "route forestière")	Forest roads are mainly concerned by the Code Rural , especially articles L161-1, L161-2, L161-3, L161-7, -8, -11, L162-1, -2, Some articles of the Code de la Voirie Routière (code of the roads) are also addressed to communal roads or private roads used for wood transport such as L113-1, L141-1, -8, L121-1, L161-1, L162-2, L162-4 The Code General des Collectivités Territoriales and, of course, the Code de la route have also some articles dealing with private network
	Internal road (chemin intérieur) such as forest road or skid trail ("piste de débardage")	

Rural roads have a hybrid status considering that they belong to the private domain of the municipalities with specific protection rules. Compared to municipal roads, they deserve less important area such as isolated farms or small groups of houses. The major can close the access to those small roads to more than 3 tons vehicles when, by example, the running surface of the road or some other equipment (bridges, etc.) are too fragile (Code Rural R161-10).

Forest roads are situated in the private domain. Some of them are running through several properties. Their status is hybrid as they are an addition of private section but there is a collective right to use it for wood haulage by example. The major can close the access to the forest roads for safety reasons. (Code Rural L162-1).

Internal roads are located in one property. The owner is free to forbid or authorize the access to people. He can also ask for fees when the road is damaged by trucks or tractors.

Skid trails can be considered as internal roads.

3.2.2.1 SOME TECHNICAL CHARACTERISTICS

In the Alpine area of France, forest roads are more often one way road. In steep terrain, they may require excavation works and pavement with external material (stones, gravels…).

Skid trails need very few work as their running surface is natural soil.

The maximum gradient of forest roads is 8% and 8 to 12% for small portions when necessary

In steep terrain, it is necessary to have some curves with diameter less than 50 m. Consequently, the width of the road must be adapted so that the truck and its load can go through the turn without any problem:

- Straight road: 3.5 m
- 50 m (diameter) curve: 3.5 m
- 31 to 50 m curve: 4.0 m
- 16 to 30 m curve: 4.5 m
- 10 to 15 m curve: 5.0 m

3.2.3 GERMANY

Most of the forestry law and regulations in Germany referred to forest roads are developed on a regional scale. That means most of the federal states like Saxony or Thuringia have their own regulations which can differ from each other. There is one so called "DWA – Regelwerk" (DWA - worksheet) which is known in whole Germany. This guideline "standard for rural road construction" is an important however not the only source of knowledge for technically correct solutions. Everybody can make use of it. There is no duty by law or legal regulations to apply the guideline. The guideline is related to forest roads and roads used for agriculture as well. In the following chapter we will give information about forest road construction in Bavaria which refer to the legislation from Bavaria, especially Bavarian Forest Act and Bavarian Nature Conservancy Law.

3.2.3.1 BAVARIA

In Bavaria there is no law which is specifically aimed at roads for forestry, agriculture and pasture management activities. Some laws deal with forest roads, such as the Bavarian Law for Roads and Pathways and the Bavarian Nature Conservancy Law.The Bavarian Forest Act contains numerous regulations and statements.

Most important is the "Common announcementt of the Bavarian State Ministry for Food, Agriculture and Forestry and the Bavarian State Ministry for Environment and Health, Construction of Forest Roads and Nature Conservation", 7905.5-L, dated from 26. September 2011.

[Waldwegebau und Naturschutz, Gemeinsame Bekanntmachung der Bayerischen Staatsministerien für Ernährung, Landwirtschaft und Forsten sowie für Umwelt und Gesundheit,7905.5-L, vom 26. September 2011]

The announcement sets the framework for the construction of forest road in general, in nature reserves, in the alpine space and in regions with specific interests for nature conservation. As distinct to other countries there is no explicit tonnage classes fixed. These can be found in two other sources: 911-L, Enforcement of the Bavarian Law for Roads and Paths and in the enforcement of road inventory in the range of the Forestry Administration; Common announcement of the Bavarian Ministry of the Interior, Building and Transport and the Bavarian Ministry of Food, Agriculture and Forestry, , dated from 22. Januar 2014.

[911-L, Vollzug des Bayerischen Straßen- und Wegegesetzes und der Verordnung über die Straßen- und Bestandsverzeichnisse im Bereich der Bayerischen Forstverwaltung; Gemeinsame Bekanntmachung der Bayerischen Staatsministerien des Innern, für Bau und Verkehr und für Ernährung, Landwirtschaft und Forsten vom 22. Januar 2014]

The last one refers as well to the 7904-L, guideline "Grants for measures for opening-up of forests within the framework of a forest subsidy programme" [7904-L, Richtlinie für Zuwendungen zu Maßnahmen der Walderschließung im Rahmen eines forstlichen Förderprogramms (FORSTWEGR 2007); Bekanntmachung des Bayerischen Staatsministeriums für Ernährung, Landwirtschaft und Forsten vom 12. März 2007 Nr. F 2-NW 264-1716 in der Fassung vom 5. August 2010 Nr. F 2-NW 264-2354] and to the technical guideline DWA-A 904 (2005) for road construction in the rural areas by the "German Association for Water, Wastewater and Waste (DWA)".

Both the Bavarian Forest Administration and the enterprise Bavarian State Forest refer to this guideline for the construction and the maintaining of local forest roads. Hence this guideline is of utmost importance.

Requirements for new roads differ in depending on terrain, for example slope and frequency of use.

- A: roadways: trucks with or without trailer, admissible total weight 40 tons
- B: skid trails: forest harvest and logging machines, tractors, hauling winches
- C: other rural trails: trails specially for pedestrians, hiking trails, bike trails, riding trails, cattle drives; forestry is scarcely concerned)

The characteristics of the road such as width and radius of curvature depend on the slope of the area..

New roads have limitations concerning maximum slope, which should not be more than 8% (exceptions up to 15%), the maximum road width should be not more than 4,0 - 4,5 m, shoulder included, the minimum curve radius is 20 m in more flat terrain (-8%) and can be adapted to terrain and slope at 12 m at least.

Small parts of the road can exceed these values without declassing the road class. Nevertheless, roads and skid trails always should have the least possible steepness. Erosion shall be taken into account as much as it increases with steepness; it reduces the stability of the structure and the driving conditions.

Not all forest roads or skid trails are built in accordance to these requirements. Some are restricted by slope, some by width, some by limited trafficability year-round. Others are restricted because of tonnage of a bridge, an underpass, which is too narrow or too low, be it a part of the forest road itself or of the access road. Therefor all available data on forest roads are collected in the NavLog System all over Germany to provide logistics with all possible information available.

Forest roads								
Class	**Transitability**		**Min. width (m)**	**Steepness (%)**		**Curvature radius (m)**		**Infrastructural works (walls, ditches, etc)**
	Vehicles	**Total Weight (tons)***		**Main**	**Maximum**	**Main**	**Minimum**	
I	Trucks	40	4,5	<8	15	20	12	Y
II	Forestry vehicles	20	3,5	<12	25	8	7,5	N

* The admissible total weight depends on the amount of axles, also the max. axle load of the table as shown in the DWA-A 904 regulations p.11, must not be exceeded.

Reference:

DWA (ed.) (2005): Arbeitsblatt DWA – A 904 Richtlinien für den ländlichen Wegebau. p. 63

3.2.4 ITALY

As most of the forestry legislation within the Italian Alpine range, also the laws related to forest roads are developed on a regional scale. It is then possible to find few common guidelines through the different regulations, leaving them to evolve according to the local importance and administration awareness.

In the following paragraph, it will be taken into account the legislation coming from some of the Alpine area, in order to define a common baseline for forest road construction standards.

3.2.4.1 LOMBARDIA

DGR 7/14016 del 8 agosto 2003 "Direttiva relative alla viabilità locale di servizio all'attività agro-silvo-pastorale"

Four classes of road payload are considered for the old and future road network:

- 1st class: Trucks without trailer with total weight below 25 tons;
- 2nd class: Tractor with trailer or light trucks with total weight below 20 tons;

- 3rd class: light vehicles below 10 tons (off-road vehicles, small tractors with maximum 90 HP);
- 4th class: light vehicles below 5 tons.

For what concerns the loads, some exceptions are made to the local municipality regulation (defined in a specific Annex) and further load can be allowed only if specifically tests have been carried on.

Dealing with the characteristics of the road such as width, radius of curvature and admissible load, have been considered the technical characteristics of the vehicles to which the class refers to.

New roads have a limitation for what concerns the maximum width of the roadway, that shall never exceed 4.5 m, shoulder included.

Steepness has been considered in relation to two different components: driving safety (slipping conditions) and erosion. The former is not guaranteed for full load vehicles on slopes above 8-10 % for heavy trucks, 10-12% for forestry vehicles with trailer and 14-15 % for tractors without trailer. These limitations are not valid for special vehicles that are not even common within the regional territory. Small parts of the road can exceed these values without declassing the road class, due to the concept of predominant steepness considered on the 70-80% of the whole road layout. Finally, erosion shall be taken into account as much as it increases with steepness, it reduces the stability of the structure and the driving conditions.

Forest roads								
Class	**Driving conditions**		**Min. width[2] (m)**	**Steepness (%)**			**Curvature radius (m)**	**Infrastructural works (walls, ditches, etc)**
				Main	**Maximum**			
	Vehicles	**Load[1] (tons)**			**Natural surface**	**Improved surface**		
I	Trucks	25	3,5	<10	12	16	9	Y
II	Tractor with trailer	20	2,5	<12	14	20	8	Y
III	Small tractors (<90HP)	10	2,0	<14	16	25	6	Y
IV	Small vehicles	4	1,8	>14	>16	>25	<6	Y
Forest tracks								
-	Forestry vehicles	-	-	-	-	-	-	N
Lesser roads								
"Mule roads"	Mainly pedestrian	-	1.2	-	-	25	-	Y
Path	Pedestrian	-	max. 1,2	-	-	100 (if stairs)	-	Y
Alpine itinerary	Pedestrian	-	-	-	-	-	-	N

[1] total load of the vehicle

[2] with lateral shoulder equal to 0.5 m

3.2.4.2 PIEDMONT

Regolamento regionale recante: "Regolamento forestale di attuazione dell'articolo 13 della legge regionale 1' febbraio 2009, n.4 (gestione e promozione economica delle foreste). Abrogazione dei regolamenti regionali 15 febbraio 2010, n.4/R, 4 novembre 2010, n.17/R, 3 agosto 2011, n.5/R"

Depending on carriageway width, steepness of the road axis and minimum curvature radius, are defined three driving conditions classes:

- 1st class: main truck roads
- 2nd class: secondary truck roads
- 3rd class: tractor roads.

Main truck roads require a minimum width on straight segments equal to 3.5 metres, while 3 m are thought for secondary truck roads and 2.5 for tractor and trailer roads; all measures are meant for the carriageway, excluded the road shoulder and the lateral ditch.

The minimum curvature radius is fixed equal to 8 m for main truck roads, 6 m for the secondary truck roads and 5 m for the tractor ones.

Finally, for what concerns road main steepness, the optimal range is considered to be between 3 and 8% for all the types, with particular cases on short sections such as 15% for main truck roads, 20% for secondary and 25% for tractor and trailer ones. The counterslope in the direction of wood transport shouldn't exceed 10%.

Forest tracks are allowed within mountain slopes with steepness till 60% (measured on a width of 3 m from the centreline).

Forest roads								
Class	**Driving conditions**		**Min. width (m)**	**Steepness (%)**			**Curvature radius (m)**	**Infrastructural works (walls, ditches, etc)**
					Maximum			
	Vehicles	**Load (tons)**		**Main**	**Natural surface**	**Improved surface**		
I	Trucks with trailer	-	3.5*	3-8	15	-	>8	Y
II	Tractor with trailer	-	3*	3-8	20	-	>6	Y
III	Small tractors (<90HP)	-	2.5*	3-8	-	25	>5	Y
Forest tracks								
-	Trucks	-	3		-	-	-	Y
-	Tractors	-	2.5		-	-	-	Y
Lesser roads								

* Road shoulder and lateral ditch excluded.

3.2.4.3 AUTONOMOUS PROVINCE OF TRENTO

DPR 15-73/Leg. del 1 dicembre 2011. "Modificazioni del decreto del Presidente della Provincia 3 novembre 2008, n. 51-158/Leg. (Regolamento concernente le modalità di raccolta, di acquisizione e di cessione di materiale forestale di moltiplicazione, la composizione, le funzioni e i criteri di funzionamento della cabina di regia della filiera foresta - legno, le modalità di funzionamento della commissione provinciale forestale e di gestione e di utilizzazione del fondo forestale provinciale nonché la disciplina attuativa della viabilità forestale (articoli 31, 32, 65, 93, 94, 95 e 100 della legge provinciale 23 maggio 2007, n.11)"

This law constitutes one of the most precise regulations dealing with the forest road topic, defining many parameters for the whole sector.

The forest roads are divided into two categories: ordinary forest road and truck forest road, which, by definition, should end with a turning point. The optimal mean steepness is considered to be between 3 and 8%, with a maximum counterslope equal to 10%.

Forest roads								
Class	**Driving conditions**		**Width (m)**	**Steepness (%)**			**Curvature radius (m)**	**Infrastructural works (walls, ditches, etc)**
					Maximum			
	Vehicles	**Load (tons)**		**Main**	**Natural surface**	**Improved surface**		
Truck road	Trucks with trailer, special vehicles	-	Min. 3.0 Max. 4.0	3-8	-	12 (18*)	8	Y
Ordinary road	Tractor with trailer	-	Min. 1.8 Max. 3.0	3-8	-	16 (20*)	5	Y
Forest tracks								
	Tractors, special vehicles	-	Min. 1.8 Max. 3.0	3-8	16 (25*)	-	4	N
Lesser roads								
Path	Pedestrian	-	Max. 1.2	-	-	-	-	N

* Maximum steepness on sections shorter than 50 m.

3.2.4.4 VENETO

DGR 341 del 6 marzo 2012: "Nuove direttive per l'applicazione della "Disciplina sulla viabilità silvo-pastorale". Revoca delle deliberazioni n. 6798/92, n. 3048/93 e n. 6038/94. Legge regionale 31 marzo 1992 n. 14 e successive modificazioni ed integrazioni."

The last law concerning forest roads within the territory of the Veneto Region does not include technical parameters for the definition of main and lesser roads. Indeed, shall be considered forest roads all those ones which fall into territory under hydro-geological regulation and that are characterized by homogeneity and a predominance of usage for forestry and pasture management activities in terms of length or administrative competency. A list of all the forest roads, among which all the existent ones with carriageway wider than 2.5 m are included, is made by the single municipalities and collected as a regional database.

3.2.5 SLOVENIA

3.2.5.1 THE "FOREST ACT" AND LEGAL DEFINITIONS

In Slovenia, the definition of a forest road is given in the Forest Act and, in more detail, in the Rules on Forest Traffic Routes.

According to the first sentence of Article 38 of the Forest Act, forest roads are "*forest transportation routes which are primarily intended for forest management purposes, are an integral part of the forest or other land which they transverse, and are public in character. The Slovenia Forest Service (SFS) maintains a register of forest roads*". The Forest Act specifies the purpose of the forest road as being primarily intended for forest management but also allowing access to "farms, hamlets or villages, as well as tourist, day-trip and other similar facilities".

The above definition also determines forest road ownership. By classifying a forest road as an integral part of forest land, the owner of the forest also becomes the owner of the forest road which crosses his or her property. Road ownership is not unlimited since roads may also be used by other users, provided such use is in accordance with the forest road use regulations. The non-forestry use of forest roads is classified in the Act as "the public character of forest roads".

The definition of a forest road is made complete with the provision that "the SFS maintains a register of forest roads" which contains the following data: name, category, length in metres, technical elements, classification into spatial units (e.g. forest management area, municipality). In addition to attribute data, the records also include graphical road information. For this purpose, the SFS has developed the Forest Road Information System and upgraded it with a web application which can be accessed by users via a user-friendly tool called the Forest Road Register (in Slovene: Evidenca gozdnih cest, or EGC). Therefore, a certain road may only be classified as a forest road if it is included into the state-wide register.

A more detailed definition of a forest road is given in the regulation titled Rules on Forest Traffic Routes, under which a forest road is:

- a constructed forest traffic route,
- primarily intended for forest management purposes,
- non-categorized under provisions governing public roads,
- used for rational transport of raw wood products,
- public in character, and
- included in the Forest Road Register.

The Rules expand its provisions beyond the legislation governing forestry by including forest roads into the comprehensive road network system under the category of non-categorised roads. Forest roads have to enable rational transport of raw wood products, in Slovenia commonly understood as transport by truck. The definition is expanded to include the notion of a "constructed forest road," which is relevant from the point of legislation governing construction of objects. It follows from the above that forest roads are subject to certain procedures laid down in construction, environmental and forestry legislation. Furthermore, the Rules specify a "constructed forest road" as a forest traffic route with a maximum allowable gradient of 0.5 m for most of road length.

Depending on their purpose, use and technical elements, forest roads are divided into three categories:

a. Category G1 roads are used for forest management purposes as well as daily public transport, which can amount to over 50% of total use.
b. Category G2 roads are the roads which open up more than 1000 ha of forest land and are primarily used for forest management purposes.
c. Category G3 roads are the roads which open up less than 1000 ha of forest land and are primarily used for forest management purposes.

The above categories of roads also differ in:

- limitations on the carriage of goods,
- road closure limitations,
- maintenance schedules.

As already laid down in the Forest Act, forest roads are public in character because other users, apart from land owners, may use them at their own risk. All forest roads have their own regimes of use intended to ensure optimum multi-purpose forest management and minimise the disturbance in the implementation of the functions of a forest as an ecosystem.

3.2.5.2 MAIN FOREST ROAD TECHNICAL REQUIREMENTS

The technical requirements for a new or reconstructed forest road in a given situation, in longitudinal or transverse plane, are:

- width of the carriageway in a straight line shall be up to 3.5 m;
- minimum horizontal curve radius is 9.0 m at the road axis, carriageway extensions have to be designed for curve radii below 50.0 m;
- storm water from pipe culverts may not be led directly into permanent waterways;
- maximum slope gradient shall be 12%;
- minimum vertical curve radius shall be 350.0 m;
- minimum horizontal width of the side drain, shoulder and corridor shall be 0.5 m;
- minimum diameter of concrete storm drainage structures shall be 500 mm or 400 mm for double-layer polypropylene pipes and steel casing pipes, respectively;
- carriageway transverse gradient shall be no less than 3%.

3.3 CRITICAL NODES AND FUTURE PERSPECTIVE: TOWARDS A COMMON CLASSIFICATION OF TIMBER TRANSPORTATION INFRASTRUCTURE

As shown in the previous chapters the great variability present may appear both as a strength for a local adaption and as a weakness for a global connection among the Alpine space territories. On the other side, the specific local needs reported in the different legislation can hardly be managed to allow for a unique definition.

For this reason, future efforts should drive towards a set of common guidelines to define at least a shared base that can help stakeholders from the forest sector for an easier understanding among countries and leading to a simplification of a transnational market.

In this direction, from a technical point of view, few considerations have to be made for all the auxiliary features concerning a harmonization of the wood transportation infrastructure: nomenclature, road databases and planning tools.

3.3.1.1 NOMENCLATURE

The definition of a common nomenclature and standard technical parameters is definitely the most important goal to achieve within the alpine territory. Indeed, the movement of forest companies among the different Countries in the last years have become more and more frequent. Is then often necessary to be able to offer to a foreign company a proper planning overview, both for harvesting and later for mobilisation.

3.3.1.2 FOREST ROAD DATA BASES

Forest road databases, already present in some of the partner countries, constitute a fundamental base for the development and maintenance of the network system. Some advices derived from the project can be summarized as follows:

- Data must be compatible or easily convertible for integration in route guidance system because in the future transport companies will use route guidance systems for navigation and optimization/planning of wood transport.
- Upgrading the data must be done in a collaborative way by the end-users, not only forest management organizations but also transport enterprises and logging companies. Specific procedures must be defined to control the proposed upgrading (new forest roads, temporary obstacles, unpractical section both on public and forest roads).
- The qualification of forest roads should be uniform and consistent and based on European harmonized criteria.
- A good connection between the public road and forest road network need particular attention and post processing data is necessary to make sure that this connection is well established.
- According to the fact that classical field survey (men + GNSS) for forest roads mapping are highly time consuming for a low accuracy results, the research and development action on how to use automatic acquisition of data for forest road qualification (Lidar, embarked equipment in trucks….) should be followed up in order to provide a new and cheaper conventional methods.

Public organizations responsible for Geographic Information have also to provide “first level” data and could provide the general frame housing the forest road data.

3.3.1.3 TRANSPORT PLANNING TOOLS

In some of the project countries navigation systems are already used from the enterprises related to wood transport. The experience gained in these years brought to a list of necessary recommendations for those who are interested in the implementation of this kind of technology.

- The specific national regulations must be easily integrated and taken into account in the algorithm used for timber transportation optimization from the forest to the users (e.g. public road network with specific regulations in terms of allowable payload or with particular tax). This research of optimization should of course consider the utilization rate of the trucks fleet but also the cost of transportation, including toll and taxes.
- The software's which will be developed in the future should be high speed calculator in order than they can quickly propose new options in case of unexpected perturbations and changes (climatic hazards, engine failure on truck or harvesting material in the forest, difficulties on forest roads, and changes in the delivery program of the mills….)
- Transport companies must work in a common way. Optimization is even more efficient when possibilities of allocation are higher.
- Back haulage strategy should be taken into account in the optimization tools as it is an important lever to decrease the cost of transport when using non forest-specific truck such as tractor + semi-trailer.
- Transport planning tools must be considered in a global logistic optimization with data exchanges (Electronic Data Interchange) between all the enterprises involved in the supply chain (transport companies, logging companies, sawmills, pulp mills and chipboards mills. The objectives are to have up-to-date data for planning and a good knowledge of the wood stocks all along the supply chain: in the forest, at the roadside, in the factories.