

An Alternative to Wood Extraction Activities in Forestry the Use of All Terrain Vehicles (ATVs)

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Abstract: With the advent of different equipment put into the service of human beings by modern technology, various techniques are developed to be used in the production activities. These techniques developed are intended for economical, easy and fast production which is normally costly, difficult and time taking. The lack of the use of mechanical production methods increase the cost of wood extraction activities and cause serious damages to forest ecosystem. Moreover, inappropriately planned activities also have negative impact on the remaining trees in the stands, regenerated areas and forest soil. Therefore, wood extraction makes it compulsory to use the most modern methods that minimize not only the cost but also the environmental damage. The limited use of manpower and animal power makes it necessary to use the most convenient and economical method also in wood extraction through mechanical power. In order to solve the problem, it was aimed in this study to develop suggestions regarding the examination of usability of 4x4 ATV's, which are commonly used and of high flexibility, as an alternative wood extraction method compared to the traditional techniques of wood extraction on flat terrain and gentle slopes (%0-20).

Keywords: Wood Extraction, Precision Forestry, Mechanization, 4x4 ATV.

1. Introduction

One of the definitions of forestry is to make interventions in the forest sources consciously for the sake of public welfare. Forests have long been seen to be sources for timber harvesting and the damages to forests and environment have been ignored. Today, they are considered to be natural sources of economic, ecological and social functions. In recent years, the more productive, efficient and sustainable management of forest sources requires a precision forestry management approach. When it is considered that the demand for especially fundamental forest products will increase both in Turkey and world, it is understood how important precision forestry activities are in production. In this regard, it reveals the importance of productivity, protection of environmental resources, spatial planning and quality products with high economic values as the basic principles of precision forestry in terms of national forestry in Turkey. When forest harvesting is dealt within the context of precision forestry approach, it is defined as the planning and application of spatial harvesting activities through modern techniques and technology in order to increase the quality of products, lower the losses and enhance the economic values considering the damages to stands [1].

When it is considered nearly all the forests are managed by the Directorate General of Forestry, and the dissemination of precision forestry and the utilization of efficient planning add up to the solution of most problems in advance. As in other planning activities, it is also highly significant to utilize various opportunities offered by advanced and common technology in terms of putting the precision forestry into practice [2].

Forestry activities are conducted in several ways and through various techniques. Labor intensive work is made use of in some of them while machine use, namely capital intensive technology, is utilized in some others [3]. While doing this, it is a must for modern forestry approach to take into consideration the most convenient method and procedure in parallel with technological developments, to determine how and at which level the mechanization is implemented, that is, determine to what extent the manpower and machine power should be united in economic and technical terms. For instance, no methods bear better results than wheeled vehicles do on stiff, solid and flat terrains. Likewise, for the most convenient extraction method especially for the maintenance cuttings, animal skidding is what first comes to the mind. Not only does animal skidding damage less to planted trees and forest soil but also serves better in terms of pulling the materials from maintenance cuttings because they are usually small-scale. However, animal skidding is applied in short distances while the one with agromotors (tractors) and log carriages is more economical in long distances [4]. With the technological developments in Turkey in recent years, it is now widely believed that manpower and

animal power should be replaced by mechanical power sufficiently and in a planned order in implementing the wood extraction operations in forests [5].

What is important in primary transport is that the product should not be exposed to the quality and quantity loss, the soil and saplings should be exposed to the least damage, and the efficient use of time should be provided in forestry activities. For that reason, the mechanization of the harvesting process has gradually gained importance recently in Turkey's forestry. It promotes the use of mechanization that the manpower and animal power is limitedly and unproductively used in wood extraction operations on flat terrains and gentle slopes (0-20%). Along with this, the systems that are used in small scale forestry operations and damage less to the trees left in stands and forest soil Lyons [6] make the selection of vehicles to be used in mechanization important. With this study, it was evaluated the use of 4x4 ATVs, a more cost-effective alternative and widely used in agriculture-forestry industry compared to agrimotors, in wood extraction activities in the scope of precision forestry approach.

1.1 Wood Extraction on Flat Terrains and Gentle Slopes

Thanks to the classification of terrains, today it is easily identified which vehicles and methods could be used under which conditions, which techniques should be applied in primary transport. In this classification, surface conditions are also evaluated as well as topographic features such as gradient and length of slope, altitude levels.

Considering the accepted ones by IUFRO (International Union of Forest Research Organizations), the slope classes for wood extraction activities are identified as follow:

1. Flat terrain (0-10%)
2. Gentle slope (11-20%)
3. Moderately sloped terrain (21-33%)
4. Steep terrain (34-50%)
5. Sharply steep terrain (51< ...)

It is technically and economically easy to blaze a trail on flat terrains, gentle slopes and a 12% slope is a restricting factor. Wood extraction can be made with manpower, animal power, hand-operated crane, agrimotors and forest tractors (skidding and cable skidding) on flat terrains and gentle slopes (Figure 1). Wood extraction with manpower and animal power is not preferred because the productivity is low, operational organization is difficult and the cost of making skid road is low.



Figure 1: Some Wood Extraction Techniques Applicable on Flat Terrains and Gentle Slopes.

The operations with agrimotors, despite the high productivity, can cause negative effects on the trees left on the stands, regeneration area and forest soil because of its weight, tyre volume per unit of contact patch area, tyre pressure, tyre length and maneuverability. For that reason, it is necessary to plan and implement spatial harvesting operations by using alternative techniques and technologies.

1.2 Small Scale Machine Use

Small scale machines are generally used in forestry operations where the production is limited. These machines are widely used in European countries. This is because the vehicles for production are designed according to the customers' expectations and can be modified in case of need.

In the scope of developing and widespread technology, it will play a significant role in both increasing productivity and minimizing the damages that more economical, modern and effective vehicles for production such as small scale machines are used in forestry-agricultural activities in order to diminish the negative sides of agrimotors. Day by day, such equipment is getting more involved in precision forestry (Figure 2).

2. Materialand Method

In this study was investigated the opportunities to use small scale terrain vehicles in forestry (ATVs) which are widely used also in agricultural and forestry activities as well as entertainment and tour organizations.

Although the literature review suggests that wood extraction is possible via ATV on terrains at suitable gradients, it was seen that there is no such research regarding the issue in the national literature and it was more focused on the user properties and safety in the international literature. Despite the availability of many different ATV models as the research material, when considered the land conditions, the ATVs should be 4x4 in the forestry activities (Figure 3). These vehicles can carry up to 1 tones with small scale mountable equipment (e.g. small trailer equipped with suitable lifting cranes). The minimum 4x4 system makes a significant contribution to traction on slippery, muddy and sloping lands either in summer or winter.



Figure 2: Some of Small Scale Machines.

All Terrain Vehicles, namely ATVs, compatible with any environment or condition, were first designed to do simple operations on terrains and its function was later changed and used in entertainment, construction, agriculture, forestry, tour organizations and even military duties. The ATVs of low engine volume (150-200 cc) are mostly used for the purpose of entertainment and tour organizations in Turkey. These vehicles developed with appropriate features depending on the requirements for the land conditions and the type of work can be used in all areas (Figure 4).

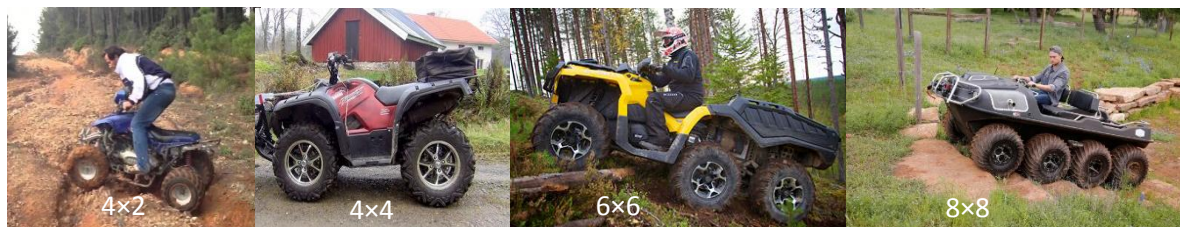


Figure 3: ATVs with Different Traction Types.

In recent years, the use of ATV has been getting popular in small scale forestry operations across the world. Beside some certain risks about safety (e.g. the lack of safety cabinets), it is preferred in forestry operations thanks to its high maneuverability, multipurpose use, relatively low capital and transportation costs. Additional equipment mounted to the ATV enables it to carry out the production operations more productively and take place more in the practice. In this regard, the ATVs to which suitable equipment is attached can also function the as primary locomotive. For this, the properties of ATVs should be as follow: having at least 300 cc engine and 4x4 traction depending also on the work type [7].

3. Results and Discussion

In wood extraction operations are made use of agrimotors, forest tractors (skidding and cable skidding), gasoline-powered hand cranes and manpower and animal power on gentle slopes in Turkey. Today, in the scope of precision forestry, wood extraction with small scale vehicles is an effective alternative method when traditional wood extraction is not suitable and the one with tractors are not preferred.

In Turkey, ATVs are preferred for recreational activities, whose area of use is widening. Another factor why they are preferred is that these vehicles, used for both recreational and other purposes, have minimum

impacts on natural sources as well as other factors. It is important for the forestry in Turkey to look for and reveal new wood extraction techniques and vehicles that are of minimum effects on natural sources in forestry

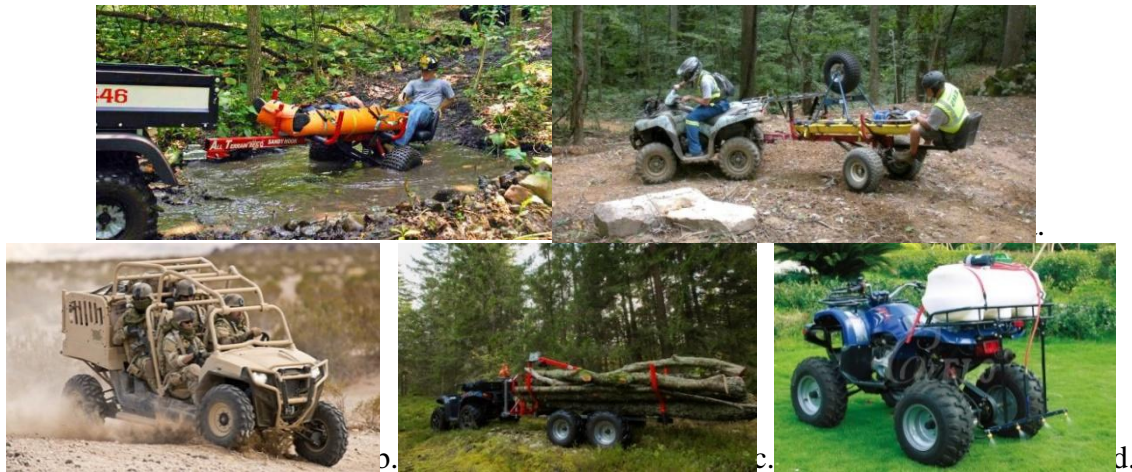


Figure 4: The Use of ATV for a. Recovery b. Military c. Forestry d. Agricultural Purposes.



Figure 5: ATV Samples Having 150 cc and 800 cc Engine Volume.

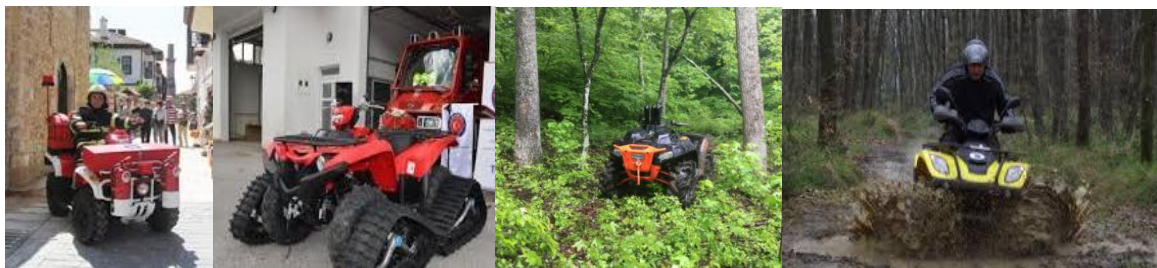




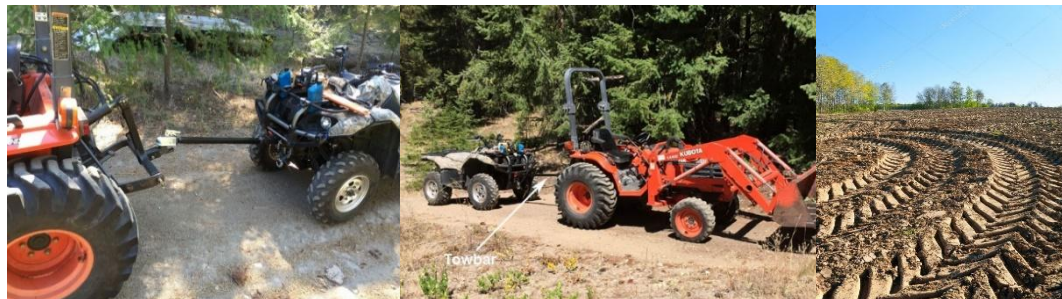
Figure 6: The Use of ATVs for the Purpose of Patrol, Fire-fighting and Recreation.

In parallel with the technological developments, mechanical operation stands out since the manpower and animal power is limited in wood extraction. In this case, what needs to be done is to necessitate the use of the most economical and convenient methods and machines that could increase the quality and economic values of products and decrease the expenses and diminish the stand damages to the forest ecosystem. In this regard, ATV is one of the vehicles that must be environmentally friendly and whose productive use must be investigated (Table 1).

As can be seen in Table 1, although tractors as more powerful machines are of high operational yield, such factors as weight, tyre volume per unit of contact patch area and type pressure are of direct effects on soil structure and texture. Moreover, when analyzed the sizes of production machines, it is predicted that high maneuverability of ATVs can diminish the stand damages with the skid roads planned according to these vehicles (Figure 7).

Table 1: Technical Features of ATVs (Alternative wood extraction method is given compared to tractors)

| TECHNICAL FEATURES | | | | | |
|---|-------------|----------|--|-------------|--------------|
|  | | |  | | |
| ATV (4x4) | | | TRACTOR (4x4) | | |
| Cylinder Volume C (cm ³) | | 800 | Cylinder Volume C (cm ³) | | 2835 |
| Max. Speed (km/h) | | 72 | Max. Speed (km/h) | | 35 |
| Maximum Power Output | | 14.80 kW | Maximum Power Output | | 51.8 kW |
| Sizes | Length (mm) | 2320 | Sizes | Length (mm) | 3995 |
| | Width (mm) | 1180 | | Width (mm) | 1990 |
| | Height (mm) | 1360 | | Height (mm) | 2440 |
| Distance Between Vehicles (mm) | | 1480 | Distance Between Vehicles (mm) | | 2250 |
| Wheelbase (mm) | | 1480 | Wheelbase (mm) | | 2250 |
| Weight (kg) | | 387 | Weight (kg) | | 3630 |
| Bale Capacity | | 212 | Bale Capacity | | 2200 |
| Wheel Dimensions | Front | 900 mm | Wheel Dimensions | Front | 1400-1800 mm |
| | Rear | 900 mm | | Rear | 1400-1800 mm |
| Wheel Pressure | Front | 45 kpa | Wheel Pressure | Front | 124 kpa |
| | Rear | 45 kpa | | Rear | 200 kpa |
| Fuel Tank Capacity (lt) | | 20.0±0.5 | Fuel Tank Capacity (lt) | | 87.1 |

**Figure 7:** Comparison of ATV with Mini Tractor (Garden-type).

ATVs, which can be used in forestry production activities, help use different plans that provide the transportation of the products in more economic way and less harmful to the stand and forest soil with the equipment mounted on the vehicle in the wood extraction stage by taking into consideration the land structure and extraction methods (Figure 8).

**Figure 8:** Product Extraction with Equipment Mounted on ATV.

The skidding/transportation operations with ATVs, usually preferred with rubber wheels, can also be implemented with appropriate land tracks. 4-season caterpillar track systems suitable for all terrains can be easily plugged in and out like wheels thanks to special connection kits compatible with all types and models of ATVs. So, it is important to be able to use such vehicles when winter cuttings are made and the regenerated land is under snow when the winter harvesting and regenerated under snow (Figure 9).



Figure 9: 4 Season Land Caterpillar Tracks.

When compared to the ones with caterpillar tracks with a similar engine power, rubber wheeled skidders are cheaper and less harmful to the soil [8]. Rubber-wheeled skidders reach the production area moving on the motorway while the track system skidders must be carried on another vehicle. Rubber wheels can be used on sandy earth at low costs for a long period. However, these wheels rub off on stony soil and rocky surface in a short time while caterpillar tracks can serve in the longer term. The traction can be increased by attaching tracks onto the rubber wheels, which are of low traction on soft and slippery soil surfaces compared to track system wheels. Because contact patch area of rubber wheels on soil surface is smaller than that of caterpillar tracks does, the earth pressure of wheels on soil is higher.

During the wood extraction operation, a layer of slash is placed on the skid road in order to lower the wheel pressure on forest soil and increase the sediment transport capacity[9]. Skidders with caterpillar tracks produce more traction on muddy and slippery surfaces. Because the tracks are of larger contact patch area than rubber wheels, the earth pressure of tracks and soil compaction are lower. In the forest areas covered with intensive understory and of hard field conditions, track skidders have higher maneuverability [10].

4. Conclusion

The effects of fast-growing and developing technology are also seen in forestry activities. Especially in production works, the efficient planning gains importance in the primary transport stage where the environment is exposed to the greatest damage and the cost is the highest. Precision forestry can take place not only in production activities but also in other forestry operations as an approach aiming to take the highest advantage of technology and raising awareness.

The limits of wood extraction with manpower and animal power feature machine work, and this entails the use of the most convenient and economical method and machines considering the productivity, cost and stand damages. An inverse proportion was determined between the productivity and cost in the works where wood extraction methods were compared and manpower, agrimotors and forest tractors were used taking also into consideration the silvicultural, technical, economic and topographic conditions [11]. This result makes it essential to examine the alternative wood extractions with different machines and methods. Eroğlu[12] stated that the most convenient wood extraction method should be used in order to take away the negative effects of production activities. In this regard, it is thought that the ATVs equipped with convenient attachments could be used in primary transport when taken into consideration the versatility, low capital and transportation costs. It is also put forth by Gümüş[13] that small trailers compatible with ATVs and equipped with a convenient crane which is able to carry up to 1 ton can be used successfully in production activities.

It is possible to name these machines versatile because ATVs (with water tanks) are used not only in wood extraction but also in case of fires which make the intervention impossible or not essential and in the national parks and nursery gardens where little intervention is needed. As well as its advantages, it should not be forgotten that they are also open to some certain risks in terms of safety (no safety cabinets); therefore, these vehicles should be modified with required equipment and outfits.

It was determined by Akay et al. [14] that skidding with a portable crane (as a small scale tool to be used on gentle slopes) would be economically more convenient compared to the wood extraction as ground skidding with agrimotors, forest tractors and cable skidding. It was emphasized how it is useful for it minimizes the potential environmental damages and costs. In these areas, they also stated that wood extraction with manpower and animal power is more convenient but the operation is of low efficiency.

It will be useful that the use of ATVs be offered to the practitioners as an alternative wood extraction method in order to overcome the cost and productivity problems and minimize the damages on stands as a result of traditional wood extraction methods. In addition, when taken into consideration that skidding the logs through channels with tractor power as more common and economical way in order to minimize the cons of uphill extraction through the skyline wood extraction operations[15], it is the same operation is carried out with low costs using a 4x4 terrain vehicle (ATV).

With traditional harvesting operations, stands are exposed to a 12-14% damage, it rises up to 20% with machines. The damage on soil surface is determined to be 42%[16]. Here, it is important to use ATVs, smaller and lighter vehicles (weight: 387 kg and length: 1180 mm), in forestry operations the machine weight on mechanical operation, tire volume per unit of contact patch area and dimensional features of machines with tire pressure so as to overcome such problems. That is, the negative impacts of mechanical vehicles used in forestry on both the stand and the physical features of forest soil can be lessened controllably.

It was emphasized by Uhl et al. [17] that while 2% of the trees in a stand is harvested, 26% of them are damaged. Baled forest assets for fewer skidding rounds can be scattered and cause damage to themselves, forest soil and saplings. It can also make the skidding surface sensitive to erosion in the long term.

As a result, it should be noted to investigate environmentally sensitive and productive opportunities by taking into consideration these opportunities in the forestry operations of widely used terrain vehicles (ATV) in agriculture and forestry industries and small scale attachments mountable to these vehicles.

References

- [1] S. Taylor, M. Veal, T. Grift, T. McDonald and F. Corley, "Precision Forestry: Operational Tactics for Today and Tomorrow", 25th Annual Meeting of the Council of Forest Engineers, Auburn University, Auburn, Alabama, 2002.
- [2] E. Buğday, "Ormancılıkta üretim planlaması ve hassas ormancılık anlayışı", *Anadolu Orman Araştırmaları Dergisi*, 2(1-2):54-57, 2016.
- [3] A.U. Gül, H.H. Acar and Ö. Topalak, "Ormancılıkta üretim çalışmalarında mekanizasyon ihtiyacının doğrusal programlamayoluyla belirlenmesi", *Turkish Journal of Agricultural and Forestry*, 24(2000):375-382, 2000.
- [4] B. Seçkin, "Türkiye'de bölme dençikarma işlerinin mekanizasyonu çalışmaları", *İstanbul Üniversitesi Orman Fakültesi Dergisi*, B/33(1):200-221, 1983.
- [5] T. Öztürk, "Ormancılıkta bölme dençikarma maliyetlerinin karşılaştırılması üzerine bir inceleme", *Kafkas Üniversitesi Artvin Orman Fakültesi Dergisi*, 3-4:212-219, 2004.
- [6] A. Lyons, "Forestry on Farms in Victoria: Do Industry and Landholders See Farm Forestry through Different Eyes", *Faces in Farm Forestry 1994 Conference*, Launceston, p. 23, 1994.
- [7] F. Russell and D. Mortimer, "A Review of Small-Scale Harvesting Systems in Use Worldwide and Their Potential Application in Irish Forestry", Dublin, Ireland, 48 p, 2005.
- [8] L.D. Kellogg and M.B. Brinker, "Mechanized Felling in the Pacific Northwest: Existing and Future Technology", *Forest Research Laboratory, Oregon State University, Corvallis, Special Publication*, 25 s, 1992.
- [9] A.E. Akay and O. Erdaş, "Orman Ürünlerinin Nakliyatının Planlanmasında Ağ (network) Modeli Yaklaşımı", *İstanbul Üniversitesi Orman Fakültesi Dergisi*, A/57(2):21, 2007.
- [10] D. Özkan, "Tiger cat 635D Sürütücü Kullanılarak Gerçekleştirilen Bölme den Çıkarma Çalışmalarının Verim ve İş Güvenliği Açısından Değerlendirilmesi", *Bursa Teknik Üniversitesi Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi*, Bursa, 62 s, 2016.
- [11] K. Menemencioğlu and H.H. Acar, "Ormancılıkta bölme dençikarma çalışmalarında transport planlaması ve etkileri (Yenice Orman İşletme Şefliği örneği)", *Gazi Üniversitesi Orman Fakültesi Dergisi-Kastamonu*, Cilt:1, No:2, s.143-151, 2004.
- [12] H. Eroğlu, "Teknik Ormancılık Faaliyetlerinin Oluşturduğu Çevresel Zararların Belirlenmesine Yönelik Teorik Bir Yaklaşım", *Bottlenecks, Solutions and Priorities in the Context of Functions of Forest Resources*, s.353-362, 2007.
- [13] S. Gümüş, "Bölme dençikarma çalışmalarında tahrikli traktör morklarının kullanımının belirlenmesi, Üretim İşlerinde Hassas Ormancılık Sempozyumu, Kastamonu Üniversitesi, s.257-265, 2015.
- [14] A.E. Akay, M. Sert, and N. Gülci, "Eğilimler azirde benzinli el vinci ile bölme dençikarma çalışmalarının verim açısından değerlendirilmesi", *II. Ulusal Akdeniz Orman ve Çevre Sempozyumu*, s.281-290, 2014.

- [15] H.H.Acar and S. Ünver, “Tomrukların oluklu çerisinde tractor gücü ile kontrollü kaydırılması (TOKK-T) yönteminde iş verimliliği, Süleyman Demirel Üniversitesi Orman Fakültesi Dergisi, 13:97-102, 2012.
- [16] R. Spinelli, N. Magagnotti and C. Nati, “Benchmarking the Impact of Traditional Small-Scale Logging Systems Used in Mediterranean Forestry”, Forest Ecology and Management, 260:1997-2001, 2010.
- [17] C. Uhl, P. Barreto, A. Verissimo, “Natural Resource Management in the Brazilian Amazon, Bioscience, USA, 47:160–168, 1997.

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