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REVIEW ARTICLE

Different views on tree interception process and its determinants

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Abstract. The subject of the study is the process of interception by plants defined as the process of retaining rainfall water on plant surface, counting retention by individual plant parts or the vegetation cover as the whole. In the quantitative approach, interception capability of plants may be compared to a reservoir, the capacity of which is determined mostly by the surface of plants. Among many approaches to describe interception processes, a lot of attention has been focused on research concerning the forest vegetation with reference to atmosphere - forest stand - soil balance. Hence, in the present paper interception issues are addressed in view of forest ecosystems. The emphasis is also put on the methods and results of studies carried out under laboratory conditions.

Up-to-date literature on interception is abundant. The authors tackling this issue regularly define their own variable and complex sets of terms. This paper is an attempt to review and organise knowledge presented in existing literature on the subject.

Key words: forest water balance, canopy storage capacity, rainfall intensity, size of raindrops

1. Introduction

In the field of hydrology, interception by plants is deliberated essentially in view of two aspects: as the component of the catchment water balance or as the element of water flow in the atmosphere-tree stand-soil system. Notwithstanding the need for systematising concepts, methods and research results, there has to be stressed that interception is an important factor in the forest water balance, which in turn has all-embracing influence on microclimate associated with air humidity as described by, e.g. Aussenag (2000).

In dynamic hydrology, the concept of interception embraces the processes ongoing within the whole catchment area and includes long-term periods of rain precipitation as well as the periods of water evaporation from plant surfaces in the periods in-between rainfalls. A broad study on this subject was presented by Osuch (1994). Interception topic has been also contemplated in textbooks, and among others those written by Soczyńska (1997) and Gutry-Korycka et al. (2003). Interception in the catchment water balance can be evaluated based on the hydrograph of water outflow at the closing profile in the catchment. The catchment average values represent the water balance components determined based on the outflow hydrograph; therefore, by definition, catchment interception assessed cannot be identified with plant interception taking place in forest ecosystems. The distinction of forest ecosystem interception is one of the key difficulties in the evaluation of forest role in the catchment water balance. There has not yet been complete knowledge on *inter alia* how tree stand taxonomic features and habitat conditions changing with time both naturally and because of silvicultural treatments, as well as various abiotic and biotic factors shape water outflow in forests with changeable interception (Miler 2008). There lack tangible parameters and formulas that would address these issues mathematically. An important at-

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tempt to eliminate this information gap can be elaboration and improvement of methodology for using data on site and stand conditions available in forest management plans to compute the parameter of physiographic conditions and to include that in mathematical models describing the effective rainfall (Soil Conservation Service – SCS) (Grajewski 2006; Okoński 2007). In the preset paper, the relationship between interception of forest vegetation and the effective rainfall was excluded.

In the context of the water balance, Sulinski (1995) lists four most important features distinguishing forest ecosystems from agricultural systems: (1) belonging to the higher level of life organisation, (2) ability to fully cover the space occupied by plants with biomass, (3) strong differentiation of the volume density of individual plant organs and (4) all-year multi-layer ground cover. These differences are probably the reason why the methodology used and the results obtained in the studies carried out on interception of agricultural plants as well as mathematical models concerning the latter (Orzeł 1980; Kowalik 1995; Kołodziej et al. 2005) cannot be wholly applied for forest plant communities.

In the studies on forest ecosystems, interception is very often analysed based on plant surface types, such as foliage, shoots and tree trunks or else there are examined precisely distinguished plant parts (Brechtel 1990). This is done for different reasons, and by and large it is about achieving a particular research goal, for example, the assessment of pollutant concentration in wet precipitation. One way or another, investigations are directed towards better understanding of the differentiation of interception as a physical process. As an example, there can serve studies on interception of the lower forest storey carried out by Nachorecka-Duda and Ratomska (2002), on interception division in stand storeys and layers conducted by Link et al. (2004) and studies performed by Calder (1999) as well as Jong and Jetten (2007) who stressed the importance of stand storeys in interception processes. Calder (1999) additionally connected the effect of tree stand storeys with the fact that raindrops reaching lower forest layers are of the smaller size and have less kinetic energy. There also have been published study results on stand interception capabilities reliant upon stand canopy closure (Głogowska, Olszewski 1967; Gash et al. 1995).

There are lots of ways to present interception as a mathematical model describing water exchange in atmosphere-tree stand-soil system. The vast majority of the formulas include the period of water reserve increase in conjunction with the period of water loss. Then, interception is somewhat hidden in evapotranspiration, which can be exemplified by Benecke's (1976) model. Suliński (1993) divides the phase of water reserve increase from that of water loss and treats interception directly as the component of the model of soil water recharge phase (1)

$$Z_p = P - \left[\left(I_d + I_r + I_s \right) + \Delta' q_s + \Delta' q_i + \Delta' q_g \right] \qquad (1)$$

where : Zp – increase of water reserves in the ground; P – rainfall above tree canopy; I – interception of: d – trees, r – ground cover, s – litter; Δ'q – water runoff from slope unit during water recharge phase: s – surface; i – interflow; g – ground.

In this approach, interception can be estimated as the difference between a singular rainfall and an increase in water reserves in soil (most of all – leaching soil) with the groundwater table freely available to plant roots. In the water balance model, interception is included in the phase of soil water recharge and it reduces the amount of water that reaches soil. The works of Suliński and Owsiak (2009) and Suliński and Starzak (2009) confirm the usefulness of models constructed in the above way.

Interception is an important numerical component of the water balance. Pike and Scherer (2003) expressed the view that interception was the key issue in forest hydrology. Already Zinke (1967) and Blake (1975) pointed out a possibility of rainfall interception by forest tree stand ranging from 10% to 30% and identified significant factors in interception measurements, i.e. air humidity and stand canopy closure. Calder (1999) reported interception value as high as 50%.

Notwithstanding differences in forest species composition as well as forest structure and density, and also rainfall characteristics associated with climatic conditions, interception should be included in simulation models of the processes such as evapotranspiration, soil water outflow and ground retention (Chang 2003) or else in the water balances with special purposes, as for example those investigated in geochemical studies (Hörman et al. 1996) or in research on nitrogen circulation in the atmosphere (Loescher et al. 2002).

Literature with available data on interception measurements obtained in certain geographical and forest stand conditions has been abundantly available. In Poland, rich data sources on stand water interception are the works by Ostrowski (1965) and Olszewski (1965, 1984). The compilation of interception values obtained in local observations was attempted by, e.g. Pei et al. (1993). The majority of researchers determined interception as the difference in rainfall measured above and under tree canopy (Olszewski 1984; Aston 1979; Jetten 1994; Feliksik et al. 1996; Calder 2001; Gomez et al. 2001; Bryant et al. 2005; Pypker et al. 2005). Spatial and temporal distribution of interception is difficult to compile; thus, there prevails the view that in practice comparisons of the results obtained under different conditions is too difficult due to methodological variations as well as research site differentiations and different timings of the measurements carried out (Crocford, Richardson 2000; Jong, Jetten 2007).

2. Factors influencing interception processes

In the light of knowledge on wetting processes ongoing on various surfaces (not only those of plants) and water retention on them (Stankiewicz 1971), there should be recognised that it is essential to reflect on the status of the wetted surface when investigating interception.

It is commonly accepted that interception volume is directly related to the size of the surface of the aboveground plant part. In earlier studies, there were undertaken efforts to describe tree surface area based on its similarity to other tree or stand biometric features. For example, Czarnowski (1978) or Teklehaimanot and Jarvis (1991) assumed the linear relationship between interception and the number of trees per hectare.

At the present time, in the majority of the studies on interception, the crown area is determined with the use of leaf area index (LAI) (Harrison 1993; Hurcom and Harrison 1998). This approach is associated with the development of methodology and equipment used for LAI determination. Water retention capability of tree crowns was linked to LAI values by *inter alia* Klaassenet et al. (1996). These authors state that the tree crown, i.e. its structure and dimensions, decides on the percentage of the total rainfall, which does not reach soil. Relationship between LAI and interception of stands was observed in different types of stands by Gomez et al. (2001), Hall (2003) as well as Jong and Epema (2001). The latter authors additionally pointed to a possibility to determine LAI distribution in tree crowns by means of photograph spectral mixture analysis. The importance of LAI values distribution was analysed in the later study carried out by Jong and Jetten (2007). The authors stressed that the relationship between plant water retention capability and LAI had been understood only for some plant species and vegetation types, but tree crowns were not the case due to too scarce data available.

Llorens i Gallart (2000) proposed basic measurement methods for the assessment of tree crown ability to capture rain, but Bryant et al. (2005) pointed out that appropriate data interpretation required the full description of crown parameters in conjunction with climatic conditions.

The development of mathematical models describing the transformation of rainfall into outflow, where individual types of retention are perceived as the system of reservoirs, forced treating plant interception as a specific kind of reservoir with a certain volume. An attempt to determine water capacity of Scots pine interception reservoir was undertaken by Osuch et al. (2005, 2005a). These authors calculated the area of leaves and that of the bark separately, if possible – with the division of the vertical cross-cut of the tree into sections. The green area was treated as a unified patch capturing water on its top and underneath surfaces. They distinguished the bark of young and older shoots due to the fact that the latter have higher water retention capacity. The authors noted that at the end of the vegetation season – at the start of defoliation processes, rain adhesion on leaves was higher. They also drew the attention to the difficulties in converting data on selected trees into statistics concerning the whole stand on a certain area.

In view of contemporary knowledge, the size of plant surface that retains rainfall is a prevailing but not domineering factor in the determination of plant interception. Other factors associated with the state of the surface can significantly influence water retention as well. However, separate examinations of all the factors that theoretically should be included in the calculation pose a lot of difficulties in reality.

Some of the opinions on the influence of species features on water interception are of hypothetical nature but not the statements based on research results. For example, there is the view proclaimed that the coniferous forest lets less water through its canopy when compared with the deciduous forest. The reason for that is the fact that water is captured at needle tips in form of droplets, whereas it flows down wetted areas of flat leaves relatively easily. The subject matter is hard to explore given that tree interception is quite small after one rainfall. For example, Rutter et al. (1975) determined saturation capabilities of the canopy of deciduous trees (common hornbeam and red oak) and those of coniferous trees (Douglas fir, Norway spruce and black pine) as 0.5–2 mm. Consequently, there has to be accepted the opinion of Keim (2004) that crown capability to intercept water can be treated as the fixed value only in the case of singular rainfall, bearing in mind that subsequent rainfalls would modify this value.

Crockford and Richardson (2000) recognised crown capability to intercept water as a key species feature affecting interception. On the other hand, Bryant et al. (2005) concluded that tree stands differentiated with regard to species composition were similar in terms of water losses.

Osuch (1994) and Osuch et al. (2005) drew attention to seasonal changes in the ability of plant area to intercept water. Analogous changeability was observed by Zeng et al. (2000). At the moment, there is a lack of clear evidence that this should be connected to rainfall temperature altering in the seasons or else with morphological foliage features which also change with time. Theoretically, the temperature of rainfall or foliage surface should constitute important factors of rainfall adhesion. At the same stroke, rainfall temperature significantly influences the size of raindrops (Owsiak et al. 2013).

Among the factors influencing interception volume, there is a degree of contamination of plant surface with dirt, which changes during the vegetation period (Jong and Jetten, 2007). It is worth adding that dirt film is influenced by the presence (or lack) of waxes impregnating cuticular membrane that covers leaf epidermis, and the latter depends on natural species features and possible effects of atmospheric pollutants (Gruszka 1991). The volume of water intercepted by plants is reliant upon not only the leaf area, but also upon plant species features and its status as well as rainfall characteristics. With regard to the latter, rainfall intensity and the size of raindrops are two main factors emphasised in literature on the subject.

Schulze et al. (1978) performed regression analysis of interception losses dependent on rainfall duration. Rainfall intensity was analysed in four intervals: 0.0–1.4, 1.5–2.9, 3.0–5.9, > 6.0 mm/h. The results obtained showed that interception increased together with increasing intensity of rainfall if it was adequately long. Similar observations were reported by Hattori et al. (1982). Several authors, e.g. Yulianur et al. (1998), Yoshida et al. (1993) and Hashino et al. (2002), determined interception as the mean value per 1 h of rainfall with average intensity and confirmed strong correlations between the factors analysed.

Suliński (1993) reviewed 117 interception cases described in subject literature with the aim to verify Czarnowski's equation on stand interception (see equation 4, Czarnowski, Olszewski 1968; Czarnowski 1978) and concluded that the amount of water captured on trees was proportional to the size of their surface. The author also drew attention to the fact that interception volume was determined not so much by rainfall volume itself but also rainfall intensity.

At the start, the surface of plants is quickly covered by water, and then the process slows down until reaching the maximum water cover value. Osuch (1998) connected this phenomenon with rainfall intensity and the plant density index. The effect of rainfall intensity on interception volume is not always of linear nature. It depends on rainfall intensity value (Lorens et al. 1997; Caryle-Moses 2004).

Tsukamoto et al. (1988) assessed 1-h values of tree interception at low rainfall intensity and stated that interception volume was proportional to rainfall intensity only in the range of up to 7.0 mm/h. Toba and Ohta (2008) also observed that interception increment decreased exponentially with increasing rainfall intensity. Interception varied a lot when rainfall was low, and then it did not exceed 0.2 mm.

The role of rainfall intensity in shaping interception volume is of key importance, however, up to date it has been poorly understood, and that is why Asdak et al. (1998) as well as Tobo and Ohta (2008) stressed a need for undertaking further studies on this issue.

Deliberations on physical aspects of raindrop formation and its adhesion on plant surface, which were fundamental to building up better structured theoretical knowledge on interception, have been subject of interest for a long time. For example, there was discussed the effect of the size of raindrops on the energy of its fall onto ground and plant surfaces (Chapman 1948). The influence of rainfall characteristics on water amounts captured on plants was described by Robin (2003). Indisputably, the studies on precipitation have so far prevailed in the field of meteorology. Recently, rainfall investigations have become important in hydrological research, and more than ever after bringing laser measurement equipment into practice, which allowed investigating the processes of formation and transportation of water droplets in the air.

Hall and Calder (1993) carried out the experiments with a rain simulator using a laser precipitation monitor (disdrometer) and showed that wetting parameters, which determine how much water can be intercepted on the plant, depended on raindrop size as well on the number of droplets formed as a result of bouncing off the surface. The authors suggested that relations between raindrop size and rainfall intensity should be better understood as an important factor in interception assessments.

Tores et al. (1994) showed relationships between raindrop sizes and rainfall intensity. They observed the changes in the parameters of rainfall during its time duration. Uijlenhoet and Stricker (1999) believed that the relationship among raindrops and rainfall intensity and interception was stronger than that so far recognised; however, Calder (1999) did not share this opinion.

According to the results of Calder et al. (1996) and Calder (1999), the capability of crown to intercept water increases with decreasing raindrop size and rainfall intensity. Calder (1999) subdivided rainfall into the fractions of primary and secondary contact with the plant and linked these with the trees in forest storeys. Link et al. (2004) stated that the size of raindrops had not as much influence on water interception in the second storey of tree stand because the latter was reached only by the raindrops bounced off top branches.

Calder (1999) tried to explicate the effect of water losses on plant interception at a global level by means of stochastic models. In coniferous forests growing under temperate climate, interception is very high due to small raindrop size and relatively low rainfall intensity. In tropical forests, where rainfalls are characteristic of high intensity and large raindrop sizes, interception is low due to wetting of the leaf area in short supply. Also, generally larger leaf area in tropical forests when compared with that in temperate forests contributes to the aforesaid differences in interception as well.

3. Selected models of tree interception

The mathematical formulas that describe interception volume in forest vegetation can be generally divided into two main groups: (1) based on physical features of the process of water interception by tree canopy (Rutter 1971; Gash 1979) and further modified (Massman 1983; Mulder 1985; Liu 1988, 1992) and (2) regression equations of purely academic character or further founded on natural determinants (Horton 1919; Merriam 1960; Leonard 1965; Czarnowski i Olszewski 1968; Czarnowski 1978; Aston 1979; Massman 1980; Calder 1986; Suliński 1993).

The models placed in the first group are based on the determinants associated with water balance calculations concerning tree surface. As an example, there can serve the works of Rutter et al. (1971, 1975, 1977), which resulted in forming the model describing changes of canopy water capacity during rainfall (Rutter and Morton 1977):

$$\frac{dC}{dt}=(1-p)R-E-k\left(e^{hC}-1\right) \tag{2}$$

where C – is the canopy water capacity, p – free throughfall coefficient, R – rainfall, E – evaporation k, h – empirical parameters, t – time duration of one rainfall.

In the models from the second group, there is considered information based on measurement results indicating that interception increases only with a certain amount of the total rainfall.

Seppänen (1963) (and also Leonard 1967) proposed the following interception model:

$$i_{dk}=\left(X_1+X_2E_t\right)\left(1-e^{-cP}\right) \tag{3}$$

where i_{dk} – canopy interception, X_1 and X_2 – measures of the leaf area and leaf surface moisture; E_t – evaporation from the leaf area in time P – above-canopy rainfall in time t; c – proportionality factor.

The cited form of the model (3) has been modified several times in line with the results of specific research (Liu 1997).

Czarnowski and Olszewski (1968) built a similar model of hornbeam stand interception:

$$i=i_m\left(1-e^{-\alpha P}\right)=10.1\left(1-e^{-0.06P}\right) \tag{4}$$

where i – interception, P – above-canopy rainfall; i_m – maximum possible interception, when $P \rightarrow \infty$; α – the species constant value.

Czarnowski (1978) presented generalised form of the above model (4) in the first edition of plant ecology textbook. The model includes a novel approach, i.e. the introduction of maximum interception, which depends on the size of plant surface and the parameter called 'rainfall adhesion'.

Sulinski (1993) verified the above model (4) and proposed the following alteration:

$$i_d=\left[\beta i_{0d}\left(0.157\sum_{j=1}^{n}D_jH_jN_j\right)\right]\left[\left(1-e^{-\varphi s}\right)\left(1-e^{-\gamma t}\right)\right] \tag{5}$$

where i_d – tree interception (mm); i_{0d} – initial interception (mm); D_j, H_j, N_j – average diameter breast heights (cm), tree height (m) and tree numbers (thou. sp./ha) for a given species j; s – intensity of one rainfall (mm/h); t – time duration of one rainfall (hours); β – surface status parameter (rainfall adhesion), ϕ, γ – scaling parameters (to compute at model classification).

The above model (5) indicates that the process of interception can be compared with filling up a leaky reservoir with the capacity defined as potential interception, replenishing of which after one rainfall depends on the intensity and time duration of this rainfall.

The model built by Aston (1979) can serve as an example of the search for an appropriate model including the effect of rainfall characteristics on shaping interception:

$$I=C_pS_{\max}\left(1-e^{\frac{\mathrm{k}P}{S_{\max}}}\right) \tag{6}$$

where I – tree canopy interception; C_p – function of canopy water coverage; S_{max} – maximum water capacity of canopy (mm); k – tree crown coefficient; P – precipitation amount.

In the above model (6), the effect of rainfall amount on shaping interception was expressed according to the Mitscherlich function, however, with alteration of the scaling factor for P variable into k/S_{max}. The author of the model stated that the value k of each dense and closed crown in fact depends on LAI, tree crown structure, rainfall intensity and wind power, even though k value theoretically = 1. Therefore, bracketed component of the model reflects not only rainfall characteristics but also includes a broader perspective.

4. Studies on interception carried out under laboratory conditions

Direct field measurements of forest trees and undergrowth are still complicated with regard to methodology and logistics, even though at the present time, there has been widely employed radar and laser equipment allowing for investigations on the movement of raindrops through vegetation layers. Thus, qualitative descriptions of interception do not provide neither for required precision nor generalisation needed in hydrological studies. Hence, the advancement on knowledge on the factors shaping forest community interception can be reached up to a time based on studies carried out under controlled conditions (Anzhini et al. 2007). And the results of these can provide numerous data for building mathematical models based on ecological criteria (Czarnowski 1978; Suliński et al. 2001).

Laboratory research on interception is conducted with reference to individual trees, the size of which allows for their placement on measurement stations designed for controlling both the parameters of sprinkled with water object and those of simulated precipitation. It should be noted, however, that the results obtained on interception of individual herbaceous plants or else trees do not clearly translate into interception of the whole stand (Czarnowski 1978; Rupert 2013). There exists a risk of neglecting the factors that seem inconsequential under laboratory conditions but are important in estimating interception under field condition. For example, Liu (1997) did not take into consideration evapotranspiration between subsequent rainfalls when interpreting the laboratory results obtained in his study.

Pei et al. (1993) studied the aspects of rainfall capture in the canopy and concluded that interception model built should also include the description of interception changeability due to rainfall intensity and canopy features. Consequently, the authors carried out an experiment under the conditions, which allowed for controlling both precipitation intensity and the parameters of sprinkled surface (pine tree, 4-m high, 4.21-m^2 crown projection area). In the course of the experiment, the leaf area was measured with LAI 2000 Plant Canopy Analyser so as to manage scheduled decrease of leaf area treatment with water. Precipitation intensity was regulated with specific equipment steered by computer software. The results of the experiment allowed for conclusion that the more precipitation intensity increases the lesser water stays on plant surface. At the same time, interception increment reaches its maximum value faster at greater precipitation intensity. The authors pointed to a need for further investigations on maximum factual interception per surface unit. In the context of Poland's precipitation conditions, the results of this study draw attention to great intensity of simulated rainfall.

Potuhena and Cordery (1996) investigated the interception of fallen down pine needles from 15-year-old pine stand and fallen down leaves and shoots from eucalyptus forest. They also took samples of forest undergrowth from both types of analysed forests. Interception of all the collected components of ground cover was measured under the conditions of simulated precipitation in the laboratory. Interception of ground cover in pine forest was 2.8 mm, and that in eucalyptus forest was 1.7 mm. Interception capacity of all the components of forest ground cover was proportional to sample weight per area unit or else to ground cover thickness. In the case of standing grasses, interception capacity was proportional to percentage soil cover by these plants.

Suliński et al. (2001) carried out *ceteris paribus* studies under controlled conditions with the aim to verify coefficients used in their interception model (see model 6). Two tree species were included in the study: common beech and Norway spruce. The trees were sprinkled with simulated rainfall with intensity 1.22–9.72 mm/h through 80 min (beech) and 100 min (spruce). The trees were surrounded with a cylinder limiting water evaporation from tree surfaces during water treatment. After each water treatment, the trees were air-dried. Interception was calculated as the difference between two values: mass of water used for artificial rainfall and that of water dripping from the trees. Interception values obtained showed that real interception increased with increasing precipitation intensity, interception increment reached its maximum in similar time duration from the start of water sprinkling for all experimental repetitions, and spruce tree interception was considerably greater than that of beech tree.

Klamerrus-Iwan (2010) investigated 1-m high trees of five species: oak, beech, pine, fir and spruce. At the same time, all experimental observations were made on two mock-up deciduous trees made of plastic material with constant surface parameters irrespective of water sprinkling duration. Interception was investigated with the use of original methodology on the measurement station constructed following the author's own design.

The amount of water captured by experimental objects during water sprinkling was measured 75 times on the trees observed and 30 times on mock-ups taking 1-min time intervals. The results of the experiment allowed for the conclusion that potential interception was reliant upon basic tree features, first of all upon plant surface size and its sorption capabilities that were modified during water treatment. The time needed for reaching potential interception depended on precipitation intensity and raindrop size.

Keim et al. (2006) carried a laboratory study on the shoots of nine tree species. Shoot tips were secured with paraffin and treated with simulated precipitation for 6 h. Biomass of each shoot and LAI were determined for each shoot observed. There was used a sprinkler with ability to regulate precipitation intensity in a range from 20 to 420 mm/h droplet size from 1 to 2.8 mm. On the shoots of all the tree species observed, interception increased with increasing precipitation intensity. Coniferous trees intercept less water per biomass unit, but more when calculated with reference to LAI. The leaf area was a more useful indicator of water interception capability than biomass.

Toba and Otha (2008) conducted a study aiming at broadening knowledge on the phenomenon of water droplets bouncing off the surface. A fir tree (60-cm high) was used in the experiments. Four replications of water sprinkling were carried out, and the area watered was decreased through LAI reduction by means of cutting off tree shoots. It was concluded that bouncing off droplets constituted 60% of interception, the number of bounced off droplets increased with interception, which did not depend on LAI.

5. Conclusions

Summarising up to date knowledge on plant interception viewed as the process ongoing during possible to distinct separate rainfall, it can be assumed that the attention of hydrologists seeking solutions for the catchment water balance as well those studying certain forest ecosystems is focused on interception issues. The approaches of both groups are different, not only with regard to the goals to be reached but also in terms of research methodology and result description. In all cases, various models are built, which are founded too different extents on physical laws, and not that often – on genuine knowledge concerning the principles that determine the dynamics of tree stand growth. Possibly that is why, when dealing with the catchment water balance, great attention is paid to the status of plant surface itself, and much smaller interest is focused on rainfall characteristics. This approach is uncritically represented in the studies on the forest water balance. Accordingly, it seems indispensable to conduct further studies under controlled conditions which will be directed towards more precise assessment of relationships determining the process of interception. Better knowledge on these relationships assessed using measurable parameters could be used in better understanding of the water balance relationship: atmosphere–tree stand-soil at an ecosystem level.

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