

Sleep Disruption Epidemic in Nigeria is a Public Health Paradox

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Abstract

Sleep is a prominent feature in nearly every facet of human health and well-being. Sleep determines our ability to think (cognition), dream (neuronal control), feel (emotional regulation), socialize (interacting positively with others), adapt to environmental challenges (synchronizing with the circadian and seasonal rhythms and with the geophysical cycles), and preserve our health (immune functioning, and maintenance of critical homeostatic processes). Although, sleep is widely recognized as one of the most powerful predictors of a healthy and happy long life. The amount of teaching and research on this subject in Nigeria remains abysmal. It is hoped that this new journal will position itself as a leading venue for communicating and promoting the results of research on sleep in Nigeria and Africa in general to the whole world.

Keywords:

Sleep disrupting,
environment,
Nigeria

L'épidémie de désordre du sommeil au Nigeria est un paradoxe de la santé publique

Résumé

Le sommeil est une caractéristique importante dans presque toutes les facettes de la santé et du bien-être humains. Le sommeil détermine notre capacité à penser (cognition), à rêver (contrôle neuronal), à ressentir (régulation émotionnelle), à socialiser (interagir positivement avec les autres), à nous adapter aux défis environnementaux (synchroniser avec les rythmes circadiens et saisonniers et avec les cycles géophysiques), et préserver notre santé (fonctionnement immunitaire et maintien des processus homéostatiques critiques). Bien que le sommeil soit largement reconnu comme l'un des prédicteurs les plus puissants d'une longue vie saine et heureuse, la quantité d'enseignement et de recherche sur ce sujet au Nigeria reste catastrophique. On espère que cette nouvelle revue se positionnera comme un lieu de premier plan pour communiquer et promouvoir les résultats de la recherche sur le sommeil au Nigeria et en Afrique en général dans le monde entier.

Introduction

Sleep is a highly-conserved behaviour across all known animal kingdom. While sleep behaviours may vary substantially between species, they share specific common characteristics: (i) species-specific posture and sleep habitat, (ii) behavioural quiescence, (iii) decreased brain and behavioural arousal and responsiveness to external stimuli, (iv) changed electrical activity patterns in the brain, (v) rapid state reversibility (unlike hibernation or coma), (vi) circadian sleep periodicity, (vii) sleep loss compensation in the form of increased sleep intensity and/or duration, and (viii) eye closure in animals with eyelids (Mader and Mader, 2016; Heyde *et al*, 1018).

While the behavioural criteria have been widely used to distinguish sleep from wakefulness, the finer grains of sleeping are usually defined using electrophysiological markers.

Sleep in human beings consists of two core sleep stages: slow wave sleep (SWS) and rapid-eye-movement (REM) sleep, which alternate in a cyclic manner. In nocturnal sleep, SWS is predominant during the early part and decreases in intensity and duration across the sleep period, whereas REM sleep becomes more intense and extensive towards the end of the sleep period. SWS is marked by slow high-amplitude electroencephalographic (EEG) oscillations (slow wave activity), whereas REM sleep (also termed paradoxical sleep) is characterized by

wake-like fast and low-amplitude oscillatory brain activity. In addition, REM sleep is characterized by phasic REMs and by muscle atonia. Almost 50% of sleep in human adults is marked by a lighter form of non-REM sleep (stage "N2") that is characterized by the occurrence of distinct (waxing and waning) sleep spindles and K-complexes in the EEG (Rasch and Born, 2013).

Sleep disorders encompass all types of dysfunctions involving sleep, including difficulty falling asleep at night, poor sleep quality, early waking, circadian rhythm disorders, parasomnias, sleep-related movement disorders and sleep-related breathing disorders. Important consequence of sleep disorders are often fatigue-impaired ability to fulfil daily tasks involving memory, learning, logical reasoning and mathematical operations (Colten and Altevogt, 2006). It is estimated that 50 to 70 million Americans suffer from a chronic disorder of sleep and wakefulness. The number of cases worldwide is believed to number in the hundreds of millions (Benjafield *et al.*, 2019). Insomnia, the most common sleep disorder, reportedly affects about 30% of the adults worldwide (Ferrie *et al.*, 2011). One study found that the highest prevalence rates of insomnia were in Brazil (79.8%), followed by South Africa (45.3%), Eastern Europe (32%), Asia (28.3%), and Western Europe (23.2%) (Soldatos *et al.*, 2005). The number of Nigerians with sleep disorders is currently unknown; a prevalence rate in one private family practice population in Nigeria was found to be 27% or more than a quarter of the study population (Adewolea, 2017). The United States Centers for Disease Control and Prevention (CDC, 2016) declared insufficient sleep a major public health problem in acknowledgment of the pervasive nature of the disease.

Children and adolescents are particularly vulnerable to sleep deprivation. A survey by the US National Sleep Foundation in 2006 found that more than 87% of high school students in the country got far less than the recommended hours of sleep. The amount of sleep they were getting was decreasing, posing a serious threat to their health and academic success. A study of schooling adolescents in Nigeria reported that frequent awakenings during the night (34.6%) was the most common sleep-related problem, and this was followed by excessive daytime sleepiness (21.0%) (Peter *et al.*, 2017). The reasons why school-age children and adolescents may sleep fewer than the recommended hours in Africa include early school start times, electronic media use, competing demands including homework and extracurricular activities, family issues and sleeping arrangements, inconsistent bedtime patterns as well as neurobiological changes in sleep patterning and physiology across different stages of development (Thomas *et al.*, 2015).

Conundrum of Sleep Deprivation in Nigeria

Common causes of sleep deprivation can be sub-divided into three broadly overlapping groups: (1) medical and psychological conditions such as insomnia, sleep apnea, restless leg syndrome, various infectious diseases, and stress; (2) environmental and socio-cultural factors such as noise, temperature, humidity, irregular sleep schedules, sleeping arrangements and stress; and (3) genetics/genomics especially the effects on the circadian rhythms (Aragón-Arreola *et al.*, 2016). Recent studies suggest that physical and socio-cultural environments can influence the quality and quantity of sleep at the household and neighbourhood levels. Traditionally, researchers have examined the sleep-disrupting effects of specific features of the physical environment such as lighting, vehicular noise, temperature, humidity, air pollution, inadequate housing conditions and urbanization. More recently, growing attention is being paid to the effects of social-cultural environments (such as age, gender, violence, disorder, social cohesion, safety, specific sleeping environment, co-sleeping arrangement, and neighborhood disadvantages) on sleep duration, daytime sleepiness, sleep difficulties and sleep quality. Several potential pathways have been suggested that can link the environment to insufficient sleep (reviewed Johnson *et al.*, 2018). The physical and social environment may act together to delay sleep behaviours or cause waking up early (such as street noise, waking neighbours, noisy construction). The environment has also been associated indirectly with stress, which can mediate insufficient sleep; for example, residing in an adverse neighborhood environment can create fear of crime and violence as well as increase anxiety or affect mood which may lead to hyperarousal/hypervigilance and less time for sleep (Johnson *et al.*, 2018). Many places in Nigeria are stressful to live in and have environmental disadvantages which are predisposing factors for sleep deprivation.

Human sleep-wake cycle is determined by the interaction of the circadian timekeeping system and homeostatic processes that tracks the duration of wakefulness through the increase of the sleep pressure levels. It is now well established that the interaction between the homeostatic and the circadian processes determines the duration, the quality, and the quantity of sleep. It enables us to stay awake and be alert throughout the day despite an increasing need for sleep, and to sleep throughout the night despite a decreasing need for sleep. Circadian rhythm sleep-wake disorder (CRSWD) is caused by alterations of the biological clocks and/or concatenated homeostatic processes leading to misalignment of the endogenous circadian rhythm and the exogenous environmental cycle. Common CRSWDs include delayed sleep-wake phase disorder, advanced sleep-wake phase disorder, irregular sleep-wake rhythm disorder and non-24-hour sleep-wake rhythm disorder.

Environmental factors can foster circadian rhythm disorders through several mechanisms. Excess artificial light from streets, residences and businesses in urban setting may disrupt circadian rhythms by depressing melatonin secretion. This has been shown to synchronize and maintain the circadian rhythms, and improve the onset, duration and quality of sleep, and is also involved in sleep breathing, hyper somnolence and parasomnia. A large majority of Nigerians regularly move between rural and urban settings which can upset the circadian and homeostatic rhythms, hence the wake/sleep cycle.

Today, so much is changing in Nigeria and its society — the weather and environmental condition, urban growth, diet, physical activity, socio-cultural norms, and external stress. Each of these changes can influence sleep in one form or another. The tricky part, however, is that these changes are happening so quickly and so pervasively and have resulted in a juxtaposition of traditional and modern risk factors of sleep deprivation in most parts of the country. Limited studies in the country increasingly find changes in chronotypes (wake-sleep cycles), sleeping habits and internal sleep organization (polysomnography) in Nigerian populations. However, the relationships with the morbidity and mortality of the local population are unclear. Whether the collateral effects of sleep on endemic communicable diseases and emerging chronic diseases of modern living are synergistic or antagonistic have rarely been addressed in any study in the country. The extent to which the changes in quantity and quality of sleep in Nigeria differ from information gathered in the so-called WEIRD (Western, Educated, Industrialized, Rich, and Democratic) countries would be needed to develop appropriate intervention strategies specific to the Nigerian population.

In the following sections, I have used three examples of the major determinants of sleep to further illustrate the paradoxical nature of sleep deprivation in Nigerian context.

Weather and Sleep in Nigeria

Ambient temperature is of particular interest in tropical countries like Nigeria because of the need to consolidate both sleeping and working during the coolest hours of the 24-hour period. Studies done mostly in the lab showed that short-term exposures to heat are associated with sleep fragmentation and decreases in slow-wave sleep (N3 sleep or state N3) and/or REM sleep (rapid-eye-movement, R sleep or state R). A study of sleep habits of healthy subjects in Sub-Saharan African countries showed that most people sleep between seven and eight hours a day in both the Sahelian and wet tropical geoclimatic zones (the two major climate types in Nigeria). Under the two geoclimatic conditions, most people were inclined to be early chronotypes (morning type individuals or early

larks), especially for those who lived in non-urban areas (Buguet *et al.*, 2019). The majority of individuals living under hot-dry Sahelian conditions take customary naps in the afternoon which is not usually the case in the wet tropical region. Polysomnography studies showed that the internal sleep organization differed between people in the Sahel during the dry season compared to people living under more equatorial latitudes (Buguet *et al.*, 2019). In the Sahel, sleep tended towards elevated amounts of N3 and R sleep; it is not surprising considering that N3 is a state of energy conservation where sweating and vasodilation promote thermolytic processes to reduce hyperthermia (Jouvet, 1994). By contrast, stage R may be influenced by a combination of stress, heat acclimatization and water balance regulation [38]. The most surprising result of these studies by Buguet *et al.* (2019), is that the quantity of sleep by Africans in the tropical climate was within the range of observations that have been reported in the temperate regions (Buguet *et al.*, 2019).

Sleep and Tolerance of Infections

Optimal sleep exerts an immune-supportive function that promotes host defence against infection and inflammatory insults. Collaterally, sleep deprivation has been associated with alterations of innate and adaptive immune parameters, leading to a chronic inflammatory state and an increased risk for infectious/inflammatory pathologies. Equally important, sleep disruption impairs circadian and immune gene expression in multiple tissues including the brain, liver, and lung. The dual sleep and circadian rhythm disruption (SCRD) which is often encountered in workers that do night shifts, is well-established as a risk factor for a wide variety of infectious pathogens including HIV, malaria, sleeping sickness and various respiratory infections (Hunter *et al.*, 2022). Sleep response is believed to favour recovery from infection and inflammation, presumably through the timely functional investment of energy into the energy-consuming immune processes. This is consistent with the fact that mild immune activation has been shown to enhance NREM sleep and suppresses REM sleep. Whereas severe immune response with an upsurge of cytokine levels causes sleep disturbance with the suppression of both NREM and REM sleep (Garbarino *et al.*, 2021). This sleep change has been correlated with the course of the host immune response as observed in bacterial, Trypanosoma and viral infections (Hunter *et al.*, 2022). Through regulation of the immune system, the sleep/circadian pair can confer a number of survival advantages on the human host such as: (i) enabling the human host to anticipate times of day when risk of pathogenic challenge is highest and mount proportional inflammatory responses when activated; (ii) the rhythmicity allows immune components involved in a dynamic

inflammatory response to coordinate signals that drive recruitment and activation; (iii) circadian rhythms coordinate the metabolic processes required for immune cell activation and prepare the immune system for exposure to rhythmic metabolic cues, such as feeding. Conceptually, sleep can be regarded as an important process that has evolved to enable human hosts to tolerate and/or resist the infection and pathogenesis of diverse bacteria and viruses in the tropical environment. Today, the relationships between the human host and its parasites (bacteria and viruses) are being eroded by changes in the environment, culture and epigenome in ways that are likely to distort the sleep architecture.

Culture and Sleep in Nigeria

Culture is defined as the shared values, norms, and codes that collectively shape the beliefs, attitudes, and behaviour of a group through their interaction in, and with their environments. Within this framework, there is strong bilateral relationship between sleep (as a behavioural trait) and culture (Orji *et al.*, 2017). In most rural parts of Nigeria where night and day are nearly equal (~12 hours) and electrical lighting in the evening is often intermittent or non-existent, people typically fall asleep and rise at

dawn or the crows of the cock. Studies in tropical countries have documented the fact that the pattern of sleep in the rural parts of the country which is synchronized to the 12-hr day/night cycle is quite divergent from that in urban areas which rely on solitary, lights out, or noiseless room with heavily cushioned artifacts and housed in a roofed and solidly walled dwelling space or "nest". This ambience contrasts with the sleep site and sleep hygiene common in rural areas such as bedtimes that are fluid; multi-phase sleep with napping common; minimal bedding accoutrement, conditions that are dim or dark; and relatively noisy with people, animals, and little or no acoustic or physical barrier to ambient conditions. Co-sleeping is a common cultural phenomenon in rural areas which begins during infancy and lasts through adulthood in some places (Airhihenbuwa *et al.*, 2016).

A study of two villages in Ghana found that outdoor sleeping and other night-time activities were extensive, and pose a significant threat to the sleep structure (Airhihenbuwa *et al.*, 2016). An overwhelming majority (99%) of household members of the study participants were outdoors during the early evening (6:00 – 8:00 pm). Activities during this time were extensive and far-ranging as described by Monroe *et al.* (2016):

"Adults were returning from work in the fields and children coming home from school, women and older girls were fetching water, gathering firewood, preparing the evening meal, and brewing pito, a local alcoholic beverage. Men and older boys were driving animals into the compound and feeding them. Most activities took place in the courtyard or outside the compound. After completing chores, household members would eat dinner and bathe, activities that sometimes occurred indoors and sometimes outdoors, with variation both within and between households. Early evening was also an important time for socializing among family, friends and neighbors. Younger children played in the courtyard or outside the compound, singing, dancing, resting, and eating. They helped with chores and watched their mothers cook. Mothers carried infants on their backs while doing chores and socializing. Teens strolled around the village, meeting and talking with friends. Some junior high and high school students walked to and from night school. Classes took place indoors, but with windows open to let in fresh air. Men gathered at outdoor bars and around local food stalls to watch football matches. Some people continued working: selling food and drinks, sewing or working in small shops or kiosks. Most activities took place outside or in partially enclosed structures...." (Monroe *et al.*, 2015, p. 5).

By early night time (8:00-11:00 pm), according to Monroe *et al.* (2015), majority of the household members still remained outdoor and continued with chores, eating dinner and socializing within the compound. Students returned from night school and some continued to study while some people remained at bars or went out dancing. The most frequent motives for staying up late at night were funerals, weddings and festivals which are large outdoor events attended by people of all ages. Waking time in the villages started at about 4:00 am. Morning chores included fetching water and sweeping the floor, feeding animals, cooking and bathing. About 61% of the adults and 39% of children under five were observed to be outside between 4:00 am and 6:00 pm (Monroe *et al.*, 2015). Observed bed times in the two villages ranged from 5.25 pm to 02.30 am, with a median of 9.12 pm among all the participants. A common habit of shifting sleeping places was also reported. Many people slept outside on their yards and verandas for fresh air either on mats or mattresses and would remain there the whole night or moved indoors when the temperature got colder. Fixed bedtimes were uncommon for children as sleep occurred as needed in between quotidian affairs like during family food preparation or during evening activities (Monroe *et al.*, 2015).

This author can attest to witnessing comparable evening, night time and early morning activities in many Nigerian villages. Studies in other villages in Sub-Saharan Africa have likewise reported diverse night-time activities (inside and directly outside the home) in relation to residual malaria transmission. The activities that have been reported include routine household chores (cooking,

eating, washing dishes, fetching water and firewood, and storytelling), entertainment occurring in the evening hours before bed, routine livelihood activities that lasted throughout the night such as security and fishing, and large-scale socio-cultural events, such as weddings and funerals. Other circumstances that could temporarily disrupt usual sleeping patterns were also described such as travel, illness, and house guests, as well as seasonal changes to sleeping patterns associated with farming practices and outdoor sleeping (Monroe *et al.*, 2019).

In the context of Nigerian societies with such active night-time interactions, fluid bedtimes and wake times, outdoor sleeping locations, and co-sleeping with multiple people of different ages, it should be expected that they would experience sleep latencies, frequency of nocturnal awakenings, reduced number of hours of sleep, early morning awakening, and rapid eye movement sleep patterns. The question of the relationships of local socio-cultural dynamics to sleep structure in the country is fascinating but remains an unopened book. In his study of the Tiv forms of time reckoning in northern Nigeria, Bohannan (1967) noted that this tribe broke the period of night into three phases: sitting together after sundown, the middle of the night which overlaps with the time of the first sleep, and the time of the second sleep around 3 a.m., or a bit later. This study suggested that sleep among the Tivs in the 1950s was not consolidated but segmented into two periods, or basically is biphasic. From her missionary-ethnography work in eastern Nigeria in the 1930s, Leith-Ross (1978) provided the following conflicting views on sleep among the Igbos:

Bedtime for children or adults is elastic. On the whole I should say the Ibo takes exceptionally little sleep. The children are up and about long after dark, the boys playing, the girls helping their mothers... It is only during the rains, when the water lashes down upon hut and forest that the people get a full ration of sleep. They are not quite such early risers as those of the North, but also they take no rest during the day... Unfortunately, contact with the white man is beginning to breed in the Ibo the conviction that an afternoon siesta is of paramount importance... Doubtless the amount of sleep required varies with race and climate but one cannot help thinking that the Ibo adult would benefit by a longer period of silence and that the children would not pass through the almost universal phase of physical debility which follows babyhood if they had a rational amount of rest at night" (Sylvia Leith-Ross, 1978, p.86).

According to this description, the Igbos clearly slept in a non-normative fashion. They were naturally short sleepers (compared to the white colonialists), awake late into the night (late chronotypes) and not sleeping throughout the day. Leith-Ross (1967) opined that letting children get more sleep might lead to better health outcomes. Her assumption being that the adoption of Western culture would eventually inculcate the more natural and consolidated nightly sleep in the colony. The importation of British norms on sleep consolidation should be regarded as a contributing factor to the sleep paradox in Nigeria.

A study of school-age adolescents in Kano found the average sleep duration to be about 7.2 hours. The quality and quantity of sleep in the majority of the children were sub-optimal (Peter *et al.*, 2017). This sleep duration was consistent with the results of Oluwole (2010) and Chinawa *et al.* (2014). Another study of school-attending adolescents in Ile-Ife (Ogun State) reported the sleep duration to be 7 hr 15 mins during the week day and 9 hrs 8 mins on weekends (Olorunmoteni *et al.*, 2018) – implying sleep pressure on week days carried to the weekend. A few other studies have reported sleep issues in Nigeria are related to poor sleep hygiene. Maduabuchi *et al.* (2014), observed that adolescents have varying degrees of sleeping practice and hygiene at levels that could have predisposed them to ill health. Williams and Aderanti (2014) reported a significant association between adequate/inadequate sleep and academic performance among undergraduate students of private universities in Ogun State, southwestern Nigeria.

In another study, almost a third (32.5%) of medical students from a Nigerian university reported poor quality sleep (James *et al.*, 2011). Okunbor *et al.* (2010), also observed that inadequate sleep affected the performance of students of Nigerian tertiary institutions in rigorous fitness and recreational activities. A study of mathematical education students in Nigeria reported a dismal sleep duration of 5 hours and 19 minutes and a sleep deficit of 2 hours and 35 minutes- attributable to high use of smartphones, laptops and TVs in the last hour before going to bed (Abah *et al.*, 2018). In their study in the Middle Belt (North Central) region of Nigeria, Sanya *et al.*, (2015), observed that a substantial number of students had borderline night time sleep duration and so had potentials to transit into the problematic insufficient range. Most of the studies in Nigeria are not only cross-sectional and ecologic but focused mainly on school age students. Little information currently exists on sleep problems in the general population or the contribution of sleep insufficiency to the morbidity and mortality burden in the country.

As far as this researcher knows little attempt has been made to study sleep comparatively across urban and rural areas of Nigeria with similar cultural, environmental and genetic backgrounds. Studies along this line conducted in

other parts of the world are very contradictory. Some people argue that in urban areas, the majority of people spend most of their time indoors, thereby being exposed to relatively dim light during the day and lack of darkness after sunset (due to the use of artificial light). As a result, their sleep onset and dim-light melatonin onset are delayed. The sleep duration is also shortened, driven by the 24/7 culture. This phenomenon is sometimes referred to as the *sleep epidemic hypothesis*. Samson and his group, on the other hand, argue that compared to rural areas, the individuals in urban settings are experiencing longer duration and higher quality sleep due to improved sleep hygiene and safer, more comfortable sleep sites (Samson *et al.*, 2017; 2020; 2021). They point to small-scale agriculturalists in Madagascar and hunter-gatherers in Tanzania which display shorter, poorer sleep (compared to industrialized countries) but stronger, more synchronized circadian rhythms. This has led them to suggest that there is an unexplored trade-off between circadian synchronization (i.e., a strong rhythm) and sleep duration and fragmentation in the urban population. Another group of researchers, by contrast, find little or no difference in sleep duration between rural and urban communities (Beale *et al.*, 2018).

The results of a recent study of sleep and activity in neighboring urban and rural communities in a region of Mozambique which is rapidly developing belong in this group and can be considered to be the most relevant to Nigeria (Beale *et al.*, 2018). This study reported that, although the two communities differed in the amount and timing of daily activity, light exposure and electricity use, there was no difference in sleep duration between the urban (7.28 h) and rural (7.23 h) populations. Apparently, artificial light exposure at night in the urban area was able to delay sleep through a combination of its direct phase-delaying effects on the circadian clock, through its inhibitory effect on melatonin release, through its acute alerting action, and through a behavioural effect by allowing people to perform activities that were not possible in darkness (Beale *et al.*, 2022). In addition, the pattern of exposure to, and synchronization with light, differed between the two communities, with urban residents exposed to significantly more light at night than those in the rural community. While the rural community synchronizes the majority of their activities with the hours of daylight. Equally important, this study showed that the sleep was more disturbed and of lower quality in rural areas compared to urban areas, a phenomenon that has been called the *developing economy sleep degradation hypothesis* (Samson, 2017). Although the two communities were engaged in similar activities for up to four hours into the night, the sleep fragmentation was more associated with a number of rural lifestyle factors including a larger proportion of participants sleeping on woven mats on the floor, a greater level of

physical activity during the day and more people sleeping in the same room than urban residents. Relatedly, rural communities vary in the way they regard productivity and subordinate it to time – early wake up being often culturally associated to success and productivity in such areas. In the city, it is easier to get tired as everything is done during the day as soon as the clock tells you to. In rural areas with no electricity and alarm clocks, work is by solar time and one is tired when the work is done – and tiredness is a mediating factor for sleep.

In most parts of Nigeria, the superposition of the effects of a rapidly changing world brought about by globalization, technology, labour and economic systems, and rapid urbanization on socio-cultural traditions is believed to be creating widespread circadian mismatches and affecting the sleep patterns in both rural and urban areas. The incidence of sleep deprivation is probably so prevalent to constitute a silent epidemic. There is currently a serious gap in knowledge about sleep in the country and looking to other countries for guidance would seem ill-advised. In fact, the only conclusion that one can really draw from the many observations of communities at similar stages of development in Nigeria is that sleep duration is plastic, regardless of whether the people live in rural or urban areas and was probably so in the time of their ancestors. One can infer from the published information that Nigerians can survive for long periods with less than optimal sleep either in difference to their cultural identity or when activities of wakefulness are given higher priority. Despite the large volume of data available on the subject matter, the impacts of electrification and artificial lighting on sleep remain conflicting and this phenomenon may in fact be different from the sleep phenotype associated with cultural and/or behavioural factors in the rural areas of the country.

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