Revista Brasiliense de Engenharia e Física Aplicada

Vol. 8, No 1 – Abril/Maio 2023

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ISSN 2526-4192

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Revista Brasiliense de Engenharia e Física Aplicada

Lost in Void on a Pale Blue Dot

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Received: _08 Feb 2023__/ Accepted: _16 Feb 2023__/ Published: _05 Apr 2023_

To the partners of CALIBRE: Richard Cathcart, Charles Finkl, Viorel Badescu and David Noel

Resumo: O presente artigo faz uma síntese das principais ideias que tenho desenvolvido ao longo dos últimos anos acerca da conjuntura epistemológica contemporânea em cosmologia e áreas afins, evidenciando as contribuições disruptivas que tenho procurado trazer a estes campos. Centrei o ponto focal da discussão precisamente sobre a plausibilidade da expectativa de vida inteligente extraterrestre. A existência comprovada de planetas extrassolares aumentou as esperanças de encontrarmos um mundo semelhante à Terra, dotado de condições ambientais pelo menos para as formas de vida mais simples. Agora, o número crescente de exoplanetas aumenta a excitação pela descoberta de sinais de rádio de inteligências alienígenas, que de fato nunca vieram. O "Grande Silêncio" parece consistente com a diversidade de acidentes que ocorreram para que existíssemos, e com as prováveis restrições físicas de larga escala. Partindo-se da lógica de que a biologia não pode contrariar as leis da física, meu objetivo final é ressaltar os fatores físicos restritivos que foram favoráveis ao surgimento da vida complexa inteligente como a conhecemos. Trata-se de uma abordagem predominantemente conduzida no plano da filosofia da ciência, de modo que o leitor precisará consultar as referências técnicas indicadas para maiores detalhes formais.

Palavras-chave: cosmologia, vida complexa inteligente, restringência física.

Abstract: This article summarizes the main ideas that I have developed over the last few years about the contemporary epistemological situation in cosmology and related areas, emphasizing the disruptive contributions that I have sought to bring to these fields. I have centered the focal point of the discussion precisely on the plausibility of extraterrestrial intelligent life expectancy. The proven existence of extrasolar planets has raised hopes for an Earth-like world with environmental conditions capable of supporting at least the simplest forms of life. Now, the growing number of exoplanets adds to the excitement over the discovery of radio signals from alien intelligences, which in fact never came. The "Great Silence" seems consistent with the diversity of accidents that occurred to bring us into existence, and with the likely large-scale physical restrictions. Starting from the logic that biology cannot contradict the laws of physics, my ultimate goal is to highlight the restrictive physical factors that were favorable to the emergence of complex intelligent life as we know it. This is an approach predominantly conducted in terms of the philosophy of science, so the reader will need to consult the technical references indicated for further formal details.

Keywords: cosmology, complex intelligent life, physical constraint.

1 Introduction

Since the discovery of exoplanets, which already number in the thousands, a new wave of invigorated expectation about the existence of beings similar to us has been occupying our minds. Excited by the frequent appeals of science fiction and the invasion of fanciful conjectures about other universes, humankind revives the crucial questioning about its loneliness in the cosmos. It is believed that we have a good chance of answering definitively, in the coming decades, the fundamental query regarding our apparent uniqueness. A confirmation of the existence of other intelligent beings would have a tremendous impact on our lives, our culture and our religions. However, even if there is optimism on the part of some people, there is also an increasing recognition that the idea of being alone is very plausible (for the sake of objectivity, and for lack of comparative patterns, I hereby rule out speculations about inorganic metalloid life).

The literature on the subject of life beyond Earth is relatively wide, covering approaches ranging from the real possibilities of simple life, passing through the habitability of other planets for humankind, and reaching the debate about complex alien intelligent life [1-10]. It can be said that, despite the infancy of the subject at the time, the first serious record on habitability was the 1964 work of Stephen Dole [1]. Considering the state of knowledge in the 1960s, in many ways the book still offers useful content, sixty years after its publication. Reference should be made to Hoyle and Wickramasinghe's *new panspermia* for its daring and innovative character in contrast with the canonical thinking [11]. Particularly, in my point of view, after many decades of theory and observation[1], the resulting model predicting a cosmos that undergoes expansion brings by itself extreme restrictive consequences for the flourishing of life.

In present article I intend to summarize, by means of a philosophical discourse, the main ideas addressed in my previous works on thermodynamics and cosmology, including some recent findings in the field of theoretical cosmology. I explain to the reader that when referring him to my former papers, solo or in co-authorship, I do so because it is a continuous research with several original points, and not for personal vanity. Whenever in doubt, the reader should consult them.

2 A new look at the real situation

I've always been a science fiction reader, mainly the stories of Arthur C. Clarke and the novels of Poul Anderson, a distinguished and awarded American writer, today almost forgotten. Clarke was a visionary that influenced some of our current achievements and still potential conquests for the next decades or centuries. Anderson was a

[1] An interesting approach to the history of some conflicting ideas on the nature of the universe after Einstein's general theory of relativity can be found in the nice article of Cormac O'Raifeartaigh and Simon Mitton [12].

physicist, which certainly ensured the techno-scientific plausibility of his wonderful narratives, despite the necessary typical concessions of the genre. One aspect that always caught my attention in his literature was, as the writer Sandra Miesel pointed out, a certain fixation on the fight against entropy [13], a theme of thermodynamics that occupies a special prominent place in my scientific production. I have written many pages about my view of thermodynamics, and entropy in particular [14-16], so that the essential thing to say here is the following:

A) Entropy is a perfectly defined concept exclusively within the scope of thermodynamics, having nothing to do with stochastic approaches.
B) Entropy is a quantity that does not decrease under any circumstances, and its progress can only be slowed down.
C) There is no real reversible processes; reversibility characterizes a partial disposition and, especially, an artificial one in the sense of being forged anthropically by means of some technological device such as a thermal machine.
D) There are no real closed systems.

Failure to observe these fundamental premises has led to a series of misunderstandings regarding the general comprehension of the laws of nature with respect to the evolution of the universe. I must reiterate that this is my way on thermodynamics with interesting consequences for cosmology.

In the movies, I'm an unconditional fan of Star Trek, all the series. Unfortunately, teleportation of biological beings is a physical impossibility — both for the dissipation of energy involved (which would irremediably destroy any living being) and for the insurmountable complexity of information to be computed —, and the space-time warps, although mathematically formalizable [17], are physically beyond our technological capabilities, and we don't even know if they shall be feasible in the coming centuries. A utopian federation of planets will probably remain in the imagination of good science fiction writers. The universe doesn't care what we believe to be illogical, such as being so vast and yet harboring only one intelligent species. I think our reality is more like the recent James Gray's “Ad Astra”, in all aspects (disputes over the exploration of the moon, the capitalist model of colonization of our satellite, the absence of evidence of extraterrestrial intelligence, the always double-faced political way of dealing with crises, etc.). "We are world destroyers", so said Brad Pitt's character Roy McBride; shocking, but true. Yet, although this seems clear at least to the minority responsible for science, there is a certain infantilization of the public, something that has been happening in increasing proportions since postmodernism as a result of the massive attack of pseudoscience, the gap between society and academia, and the support of the techno-sensationalist media to the profusion of extravagant ideas about space tourism and other fooleries. Reason tells us that none of this is intended to improve people's lives, just to feed the ego of the few billionaires and jacks in offices who dictate the course of humankind. Also, we don't live in a trusting world. Journalism ridiculously feeds more and more on media lynching, dehumanization and extreme caricaturization. The manipulation of information is so blatant that I stopped following television news a long time ago. I am not a conspiracyist, but it is certain that discoveries considered strategic from the point of view of institutions in power will always be kept secret until it is convenient to disclose them.

That said, although so far we have not been able to get rational communication signals from outer space, the high likelihood of the hypothesis of absolute solitude does not rest on this fact, which, by itself, would not be sufficient for a negative answer. In fact, unless a *sui generis* combination of several events was configured — such as the balanced number of impacts of asteroids and comets on the surface of a planet so that much more is added than subtracted, a suitable combination of water and rocks, and the chirality involved in the influence of muons on the generation of mutations —, biological evolution will not be able to act in a manner analogous to what led to the human species (not to mention the need for a magnetic field strong enough to shield the planet from lethal cosmic radiation). Of the thousands of cataloged exoplanets, none is so far substantially similar to Earth. Still, there might be another Earth, though it's not a matter of probability and statistics, but of physics.

As one can easily see, the physical constraints are immense, starting with the fact that the very expansion of the cosmos conspires to distance hypothetical civilizations. An even more critical factor is that intelligent life may be fundamentally constrained by the universe's expansion rate, that is, it can only occur within a very narrow range of accelerated expansion values (only a certain average rate of expansion – corresponding to a certain average acceleration of entropy – would make the emergence of complex life viable) [10]. This way, we got lucky; we showed up at the right time, it seems[2]. When we talk about Universe's expansion, we are also speaking of the expansion of what constitutes us in ultimate essence: space-time. In order for us to exist, it is necessary that the amount of expansion in our bodies, as well as in the world on which we act, be very small in contrast to the electromagnetic ties that keep us intact. This makes us think that we have probably misunderstood gravity, mistaking it as either an ordinary force or a quantizable field. But if we model it after sub-Planckian compressions and expansions of space-time[3], we might imagine something else from dark matter to match the flat rotation curves in galaxies[4] and large scale observations. Since the expansion of the cosmic woof from a figurative dot occurs in all directions, a certain neighborhood in expansion may be being overcome in its borders by others with

[2] Of course, if there are inhomogeneities in the rate of expansion, we might expect to find bubbles of space-time potentially favorable for the emergence of intelligence.

[3] This is well intuitive since gravitational waves are successions of pulses that alternate compressions and expansions of space-time. They can even help us to understand more deeply the first moments of the universe.

[4] Space-time as a single physical entity, dually defined by a dynamic of expansion and compression, seems to encompass the two cosmic trends — while dark matter pulls matter inward, dark energy pushes it outward — in a simpler and more objective way.

greater expansion power, thus suffering a compression effect. By this reasoning, it seems, certain regions of the space-time woof are confined zones that expand compressed by their surroundings under such intensity that they end up shrinking at risk of even collapsing. It's like walking on a conveyor belt in the opposite direction without ever reaching the exit. This dynamic of interactions between expansion zones conflicting with one another can explain what I call the “dark effect”, which would aid to “close the bill” of the amount of matter, today supposedly equalized only by dark matter. We thus have the energy of expansion (dark energy) and its dark effect, which is nothing more than ongoing gravitation. This is true natural logic; for expansion to occur, something had to be compressed. We can keep our usual mathematics, however applied to slightly different objects due to the physical continuity assumed from the sub-Planckian expansion. Indeed, it is difficult to imagine something continuously small, and yet finite. But it is precisely this conception that allows the elaboration of o sub-Planckian physics that makes sense and that is not a purely mathematical lucubration.

2.1 The continuum in physics

In a nutshell, space-time compression-*cum*-expansion is equal to gravity in action, expressing the same and unique phenomenon (note that mass is never referred to; this for a very simple reason: mass only amplifies what already happens naturally in the cosmic woof absent of matter). Therefore, expansion is not, strictly speaking, due to a mysterious repulsive force, but is part of a game of opposed tendencies based on a single energy. As the expansion does not have a privileged spatial direction, dark energy is the same that compacts space-time whenever one expansion neighborhood opposes and overlaps another. As observed by Serpa & Veras (thinking physically),

“To exert gravity is to compact (dense) space-time, and to compact space-time is to contract the infinite intervals of space-time by contracting the interval that contains them into an infinite succession of intervals that contain intervals. This is precisely an example of what we mean by continuity in physics.” [18].

This is like we had, in a *Gedankenexperiment*, a infinite mirroring effect in which the images are always finite, but their sequence is an infinite and continuous change of scales.

As I've often said, dealing with infinities is not a matter of physics. Whenever we run into them it means that something is wrong with our representations. We can deal with the abstraction of an infinite number of objects, but the object itself must be finite. At this point, within the isomorphism that is sought between mathematical representation and the represented nature, there is a fundamental approach in my work: the space-time has no parts, and the intervals we suppose are not constituents of a geodesic but simple artifices of thinking. Any interval can be supposed in any scale, thus representing all geodesics. To understand with precision, let me declare an axiomatic body.

-Axiomatics-

Definition I

A_i is a finite set of closed real intervals:

$$A_i = \left([a_1],[a_2],[a_3],[a_4],...,[a_n]\right),\ i \in \mathbb{N} \,/\, i \leq n.$$

Definition II

$\mathbb{R}$ is the set of real numbers.

Definition III

$]b_j[$ are open sets of $\mathbb{R}$.

Definition IV

An application f: $A \rightarrow \mathbb{R}$ is said a "meddling" if A can be ordained in $\mathbb{R}$, such that

$$f([a_i]) \in \left(]b_{j-1}[a_j]\, b_j[\ ,\ ]b_{n-1}[a_n]\, b_n[\right),\ \text{for } j \leq i \leq n.$$

Definition V

A set A is said to be quasi-homeomorphic to $\mathbb{R}$ *iif* there exists a meddling f: $A \rightarrow \mathbb{R}$, no matter how small the selected scale of the intervals taken over A.

Axiom I

Space-time intervals are quasi-homeomorphic to $\mathbb{R}$.

What does this mean precisely? In physical terms, it is much more useful to imagine a continuum of scales, since the object has space-time factuality; it exists *in facto*, unlike the mathematical object, which exists only *in abstracto*. In other words, in physics the small is always finite, no matter how small, regardless of the fact that we cannot reach it (nature does not exist for our absolute control). *Definition IV* is a topological rule to insert an ordered set of closed intervals into $\mathbb{R}$, whilst *Definition V* is similar to tell that, physically, "a regular n-agon is quasi-homeomorphic to the circumference, no matter the scale of the hexagon", being each side a closed set, and each vertex an open set; there is no discontinuity, only a language artifact to thereabout represent what we may realize from nature. In the cosmic woof, between two closed intervals — artifacts of thought — there is always an open interval. This seems difficult to intuition because we are used to treating the physical object as if it were a mathematical entity, which is an error. As we all remember the great Bohr, physics is about what we can say regarding nature, not what nature is. Therefore, there is no point in claiming that the universe is mathematical, something that has been heard so many times. This is perhaps the greatest silliness of all time in science, a direct reflection of its postmodern distancing from philosophy.

Now, if we understand gravity as resulting from the space-time dynamics explained above, those movements of expansion and compression take place from sub-Planckian domains, since space-time is continuous. Another way to understand this continuity goes back to the Big Bang, when space and time were created. We always consider Planck time as the unit of duration for computing the first moments of the universe. The intervals are then counted as multiples of this unit. However, the universe is independent of the systems of units we have invented. There is a continuous passage of time up to the one Planck unit mark, however fast with or without inflation.

3 Back to the natural restraints

If we think that all hypothetical forms of intelligence are based on the same neurocognitive and neurosystemic principles, which is quite reasonable, we should expect essentially familiar behaviors from aliens, however bizarre they may seem. They wouldn't be so different in mental proclivities. A spacefaring civilization, or sentient agglomerate as I've called it [7], advanced million years compared to ours, living in the borders of an old galaxy, would already have mastered an unimaginable technology (perhaps even incomprehensible to us), having miraculously survived the psychosocial storms and the events that lead to extinction. It would have already colonized large regions of the outer edge of its pale and dull galaxy, considering the hypothetical natural constraint of at most one civilization per galaxy [8]. The primary of its homeworld would long ago be surrounded by a Dyson sphere, and its form of communication would be beyond our reach. With such scientific and technological power, the aliens could plan and implement a policy of colonizing other galaxies with their artificial wormholes (certainly at a high energy cost!), but why would an advanced civilization to the point of controlling colossal energies do such a thing? Perhaps in flight from its reddened dying galaxy, where hardly a new star is born, buffeted by the harmful hot wind blown from its supermassive central black hole, a constant, disquieting wind preventing new star formation. The Milky Way, although already in a slight decline, would seem a new and bright future to these aliens, and if they discovered us with our primitive chemical rockets, they would probably take us for insignificant insects. However, if they deemed it necessary to carry out preventive fumigation in the new house, I believe they would do it without hesitation (we know what happens in encounters between aborigines and conquerors!). Apart from this imaginary extreme and somewhat improbable situation, we shall remain isolated and alone, according to a suspected natural constraint that prevents contact between two civilizations [8].

In my view, in a galaxy, considering the time needed for cosmic evolution to give rise to Darwinian evolution to the point of reaching the oddity of intelligence, the spread of intelligent life would take place from what Dyson conceptualized as green technology [2]. According to him, "green technology means that we don't live in containers, but that we adapt our plants, animals, and ourselves to live haphazardly in the universe as we found it." This particularly applies to the occupation of our solar system with its impressive multiplicity of worlds, starting with a very promising satellite, very close to a virtually inexhaustible source of Helium-3 (He-3): Titan, the fantastic moon of Saturn, bigger than Mercury. As is known, He-3 is the ideal fuel for fusion engines, being abundant in Saturn's atmosphere. On the other hand, Titan has a dense, yet unbreathable atmosphere, offering a pressure compatible with the human presence, as well as a gravity that is comfortable by our standards. Although icy, it does not have strong winds, a fact that makes its climate surmountable with the protective resources we have at our disposal. As one can see, contrary to the dreamy plans of interstellar travels that are not feasible for our fragile bodies, a hospitable, balanced and resource-rich solar system appears to be a key factor for the emergence and perpetuation of an intelligent species. So far, apart from ours, none of the known systems has such a configuration; *exceptio regulam probat*!

4 The unappealable logic of nature

Just as it is unlikely that we shall be visited, for better or worse, by another civilization, it would be unlikely that we shall leave the solar system for reasons of survival, if not for other impediments, at least for the complete lack of reasonableness of such an undertaking. As hinted at in the previous section, our suite of planets exhibits configuration features that apparently favored the emergence and preservation of life. The positioning of a gaseous giant in the exact location of Jupiter, assisted by a second gaseous giant, Saturn, enabled the formation of a kind of "management barrier" for the movement of smaller bodies that could threaten the Earth, considerably reducing the chances and frequency of dramatic events over long geological periods; this gave time for intelligent life to flourish, but it was required the presence of two admirable giant worlds that completed the seemingly stable balance of the solar system: Neptune, the champion in speed of winds; Uranus, the ring-and-moon recycling champion. Also, in terms of survival of the species, the solar system looks auspicious with a great diversity of rocky moons and surely abundant water, in addition to a veritable infinity of asteroids virtually available for mineral exploration. In face of all this, I believe the idea of interstellar travel in search of other solar systems is unproductive, in fact, very far from practical reality. I still prefer to suspect there is a kind of virial principle that balances the survival potential of an intelligent species with the resources available in its own home system, dispensing the need for projects with little or no technological viability.

5 Probability, statistics and faith

Carl Sagan was undoubtedly one of my inspirations when I was a boy motivated by the telescope my father gave me at age 14. In one of his famous books, "Pale Blue Dot: A Vision of the Human Future in Space", which motivated the title of this article, he pointed out that the Voyager missions never found signs of life on the worlds of the outer Solar System, despite the fact that organic matter was found on abundance, or, as he called it, "premonitions of life" [3]. This picture has not changed with the most recent observations. Once flourished, life proves resistant judging by the damage we have done to its various forms developed on Earth, but it seems to be a very rare phenomenon outside our planet. If this is the case for life in its most primitive forms, what about complex and, ultimately, intelligent life? As Don Lincoln commented, "The expectations of a universe full of neighbors similar to us did not prove true." [5]. And continues further:

"It also seems safe to say that there is probably no civilization in our stellar neighborhood that has been making radio transmissions for hundreds of years. Nearby intelligent life, at least of the radio-transmitting variety, appears to be rare."[5].

There is also a search for laser-coded emissions, with equal failure. In any case, for those who argue that we are looking for intelligence signals in the wrong sources and frequencies, it is important to point out that it is reasonable to assume it would occur to any emerging civilization to use radio waves as an obvious first resource of communication.

As I said earlier, evaluating the possibilities of intelligent alien life is not a matter of probability and statistics, but of physics, more precisely, of physical constraints. Imagination has no barriers, but efforts to bargain with physics are futile, just as ignoring the very real obstacles to man's survival in space is a demonstration of impressive naivety, a finding that should hold true for any higher form of life well adapted to its planetary conditions. In particular, statistics, as it has often been used, has done little to advance science (this is pitiful!). Statistics describes properties of sets of numbers representing some scenario, so that predictive extrapolations can be made to larger sets of such numbers for the same scenario. At the present time, the number of known civilizations we have at hand is 1, with which we can do little but fervently wish that there are others with recognizable technological skills. On the other hand, to estimate the occurrence of a phenomenon in a context of randomness, such as in Drake's equation, countless factors would be necessary[5], some of them we have no control, and some of which, eventually, we do not even suspect.

One civilization at most in each galaxy [8], perhaps only those galaxies within the correct range of expansion acceleration [10]; this hypothesis I recently suggested does not leave us very hopeful. If so, I think it's better for everyone, humans and aliens alike. Humankind is not even ready to fully give up its worst power intentions in the name of survival, sustainable development, and a brighter future for the new generations, a bit like in "*La Nuit des Temps*" ("The Night of the Times", translated to English version as "The Ice People"), a science fiction novel by René Barjavel [19]. On the other hand, if we accept the reasonable presumption that aliens and humans should not differ much in neurocognitive and neurosystemic aspects, what can we expect from a fortuitous encounter? When in doubt, perhaps we should remain silent.

[5] Even the presence of a giant moon like ours may have played a fundamental role in establishing conditions for the emergence of life due to the tidal regime that it originates, allowing the formation of chemical slops on the continental edges with substances necessary for biological activity.

6 Never ending the limits of knowledge: many unknown unknowns

Knowledge in general astronomy and cosmology — on which everything we imagine to know about the universe depends — progresses with a lot of uncertainty, especially in astrophysical cosmology, a lot of comings and goings. Stancliffe *et al*. published an interesting article about uncertainties in stellar physics based on a project to intend to estimate the systematic uncertain ties involved in the calculation of stellar evolution tracks[6], with the following very inspiring statement:

“Stellar evolution codes are a lot like religions: there are many of them to choose from, they possess many similarities, and it is not obvious which of them (if any) is correct.” [20].

Until recently, there was consensus on the formation of the solar system from a cloud of materials originating in a supernova, as in fact supernova explosions are the providers of all the constituent elements of biological systems and of all known matter. However, the frequent presence in asteroids of a rare radioactive aluminum isotope, Al-26, raised doubts about the precise origin of the primordial cloud, since this isotope is produced only by super hot Wolf-Rayet stars. At the other extreme of the investigation are unlikely galaxies in regions very close to the Big Bang where they shouldn't be. The bizarre side of the universe is revealed in astonishing phenomena, with planets orbiting pulsars and neutron stars that behave simultaneously as pulsars and magnetars, such as the Swift J1818.0-1607, cataloged as a young radio-loud magnetar [21]. There are many surprising puzzles which succeed and interconnect in a sequence that seems to have no end. The only thing that hasn't surprised us yet is life beyond Earth.

It is a fact that science will always advance by improving or replacing its theories as we improve our tools of corroboration. Science also advances with risks and new beginnings. I remember that Einstein, in his historic reflections on the nature of the universe, proposed at a certain point, when examining more closely the hypothesis of a universe in constant creation of matter, that his cosmological constant would represent the creation term in his field equation, associating a certain energy to the vacuum, which soon proved to be unsustainable. However, I fear that the scale of uncertainty is on the way to disproportionately overcoming the few certainties that the great Laws of nature assure us. We have no idea how many unknown unknowns there are, especially when it comes to the

[6] Furthermore, the authors note that “..small systematic uncertainties in the stellar parameters may be strongly significant in terms of planet properties, for example for planets in the 5−10 $M_\odot$ transition region between gaseous and rocky planets. For these planets, underestimating the uncertainty of their mass and/or radius may lead to dramatically wrong conclusions: a planet presumed to be a super-Earth in the habitable zone may instead by an uninhabitable gaseous planet.”[20].

transition from the purely physical to the biological[7]. Dealing with so many limitations is sometimes tiring and discouraging, but that's the nature of things. This is how we move forward. As once Fred Hoyle said,

“Defining the universe to be everything there is, manifestly we cannot be expected to understand it exactly, since to do so we would need both a complete command of the laws of physics and the fantastic calculating power to work through the detailed properties of assemblies containing very large numbers of particles.” [23].

And he added further:

“The big problem in biology, as I see it, is to understand the origin of the information carried by the explicit structures of biomolecules. The issue isn't so much the rather crude fact that a protein consists of a chain of amino acids linked together in a certain way, but that the explicit ordering of the amino acids endows the chain with remarkable properties, which other orderings wouldn't give.”[23]

Still, without some degree of creativity and independence, scientific way of thinking freezes, and the freezing in theoretical physics is frequently marked by a lot of intellectual energy consumed with sterile mathematics and fanciful assumptions. Furthermore, it is customary, and even understandable, to cross one's arms in face of certain difficulties assuming a model that shows great success in some respects, leaving others aside. For instance, as much as we adopt the Standard Model as the best available option, some answers we seek exceed its possibilities, not because it is wrong, but because it does not cover certain important features that require alternative approaches, as far as possible, consistent with its main findings.

There is certainly an andragogical problem too. Physics teaching suffers from an archaic model of thematic presentation that follows the history of physics itself, without ever giving space to a disruptive perspective [24], displaced from classical ties and directly connected to contemporary findings. As well said Regan,

“Not only is physics not taught in a sequence that emphasizes our best, present understanding, this perspective is never presented. The standard physics curriculum never gets around to saying, ‘if we were starting from scratch, this is how we would do it’.” [25].

Let me go a little further, drawing attention to the fact that there are serious language problems, especially semantic ones. Obviously, these semantic problems configured in natural language end up falling on mathematical representational formalism, making the latter a erroneous justification of the misinterpretation itself. Very few

7 On this subject, it is worth reading the beautiful book by Schrödinger [22].

authors pay due attention to this fundamental subject. However, a lot of conceptual confusion would be avoided, not only in contemporary physics, but also in classical physics, where, quite contrary to what one might think, there are still many misconceptions. In the words of Lévy-Leblond,

“[…] paying attention to our linguistic choices and assessing their relevance, may be of great significance for research, as it should go beyond formalism, for teaching, as it should go beyond technicalities, for popularisation, as it should go beyond catchwords.” [26].

Lastly, as I have commented elsewhere, there is a strong tendency to fix attention on math disregarding physics in formal representation. Heisenberg had a very clear and honest position on mathematics as a language of representation:

" When we pursue rigorous mathematical methods too hard, we fix our attention on those points that are not important in terms of physics, and thereby we move away from the experimental situation. When we try to solve a problem with coarser mathematics, as I often did, we are always forced to think about the experimental situation."[27].

This clearly applies to theoretical cosmology, just replacing the word "experimental" with "observational".

7 Final comments

The points discussed here reflect a necessary neocritical view of science as it is done today. This more open vision implies disruption and innovation. I really was blessed with great open-minded advisors in postgraduate studies, both in Brazil and France. However, as not infrequently happens, a haphazard antagonist gets in the way, trying to extinguish creativity "with a stick", as it is said in Brazil. Ironically, this *persona non grata* was the reason for my later studies on white dwarfs, magnetars, and Wolf-Rayet stars, so I am grateful for the obstacles he unsuccessfully tried to create for me during a course on stellar evolution. If I had listened to the nonsense and bullying about age differences, I would not have achieved the scientific stature of today. It is with this sinister bias that Brazilian public academy banishes the less resilient and the more independent candidates, insisting with a merely repetitive model on what was already known sixty years ago.

In astronomy there is still a wide field for innovative theoretical work, including in support of astrobiology. I have tried to open my students' horizons, sincerely hoping that the new generations will bring the desire to go beyond the canons.

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Revista Brasiliense de Engenharia e Física Aplicada

Exuberant "Magic Carpet" Giga-Project Macro-Imagineering

The Arabian/Persian Gulf Shallow Draft PV-Raft Giga-Project

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Received: _08 Feb 2023__/ Accepted: _16 Feb 2023__/ Published: _05 Apr 2023_

Resumo: Processos naturais e atividades antropogênicas afetam de forma variável a diversidade climática e ecossistêmica das nações ao redor do Golfo Pérsico-Arábico. O *Magic Carpet Giga-Project*, proposto como uma contramedida de enfrentamento da aridez dos ambientes regionais, é concebido como uma vasta jangada flutuante com painéis fotovoltaicos, disposta sobre o Golfo. Conectada por cabos elétricos a instalações terrestres, a energia poderia ser fornecida para cidades e para aplicações industriais que incluiriam enormes usinas de dessalinização de água do mar para uso municipal em geral. A adaptação espacial e marítima na forma de caminhos de aproximação e desvios será necessária em razão das rotas marítimas existentes, bem como do acesso adequado às plataformas da indústria petrolífera *offshore* que pontilham o Golfo. Os macroprojetos "The Line" e "The Loop" serão áreas bem delimitadas com vegetação controlada pelo clima, enquanto o "Magic Carpet" pode se tornar um esteio de dessalinização e fornecimento de eletricidade para a futura infraestrutura básica de cada estado do Golfo.

Palavras-chave: Macroengenharia, Arábia Saudita, NEOM, jangada fotovoltaica flutuante, Golfo Pérsico-Arábico, Golfo da Califórnia.

Abstract: Natural processes and anthropogenic activities variably affect climate variability and meteorological drought in ecosystem-nations surrounding the Arabian-Persian Gulf. The Magic Carpet Giga-project, proposed as a counter measure to aridification of the regional environments, is envisaged as a vast floating PV-panel studded raft in the Gulf. Connected by electrical cables to land-based facilities, power could be provided for cities and industrial applications that would include enormous seawater desalination plants for municipal and commercial applications. Spatial and sea lane accommodation in the form of approach ways and bypasses will be necessary for designated sea-lanes, as well as according access to in-place offshore petroleum industry platforms dotting the Gulf. "The Line" and "The Loop" macro-projects are to be climate-controlled, vegetated enclosures whilst the "Magic Carpet" may become an electricity-desalination mainstay of the future basic infrastructure of every Gulf ecosystem-state.

Keywords: Giga-project, Saudi Arabia, NEOM, floating photovoltaic raft, Arabian-Persian Gulf, Gulf of California.

Nomenclature:

E	electrical energy provided by the whole PV array, kWh
h_0	global heat transfer coefficient from the photovoltaic cell to the environment medium through the glass cover, W/(m^{2}K)
H	daily solar global irradiation, kWh/m^2
I	solar global irradiance, W/m^2
P	daily electrical PV energy per unit surface area, kWh/m^2
T	temperature, °C
U_{Lm}	global heat transfer coefficient of the PV module, W/(m^{2}K)
U_b	heat transfer coefficient from the photovoltaic cell to the environment through the Tedlar layer

Subscripts

c	solar cell
g	glass
m	solar module
med	medium/mean
ref	reference
T	Tedlar

Greek letters

α	absorptance
β	packing factor
η	PV cell efficiency
τ	transmittance

1 Introduction

Multi-society human civilizations tend to rapidly progresses in multiple fields of endeavor when there is a lively presence of disruptive or incremental science and technology [1]. The emerging field of real-world Generative AI computer systems, actual versus new instances, cannot yet access unforeseeable creativity that allows *Homo sapiens* to modify the Earth's bioshell, by reshaping it incrementally or drastically according to sometimes markedly capricious wants and life-supporting most urgent needs. Therefore, it is not only necessary but prudent for human beings to project and enact the "World of Tomorrow" with the help of focused research science and accessible proved technology. In part, "*Imagination*" (the faculty or action of forming new ideas, or images or concepts of external objects not present to the human senses) is an aspect of human thinking that focuses on the future health and happiness of the individual or social group. In this vein of imagineering, this report elucidates a proposal for a spatially gigantic barge-like floating solar-power station in the marine environment. This proposed modular floating electricity-generation public utility, which if built and fully installed, could be shared by shoreline states of the Arabian-Persian Gulf region. From above, this engineered enormous raft would have the fanciful appearance of a giant carpet, sort of a "magical" rug composed of numerous modular mats that could produce electricity for the Gulf region's coastal and inland populations.

Human civilization nowadays appears to be utterly enamored, enraptured, and captivated by concepts of global relationships of air-seawater temperatures and investable monetary capital [2]. As a matter of fact, modern societies are today incessantly pestered by a near permanent, society-wide media-induced imagined sense of eminent climatological and social crisis. This media blitz is an electronic virtual informational immersion that posits an unavoidable planetary bath of heating air and expanding ocean water volume because of human action. The risky management of atmospheric heating and expanding ocean volume has become a political means of deferring apocalypse. Since the onset of the envisaged crisis, several Gulf ecosystem-nations have, however, undertaken vast and expensive climate change countermeasures to purportedly sustain their continued existence [3]!

The use of the term "*exuberant*" does not, necessarily, indicate preference toward absurd and wasteful forms of new human civilization-sustaining infrastructure. The authors do not desire, intend, or plan to replace the natural endemic with the pseudo-Edenic. Nevertheless, it is appreciated that Gulf states are anxious to quickly alter stale internal social developmental trends, unproductive and outdated habits of thought, as well as some erroneous popular notions of what is technically possible and appropriate for national long-term survival. The accountant-tabulated financial cost over-run of the Suez Canal's construction was 1900%, but that linear dredged channel was needed by humankind's then near-global cargo and passenger shipping-enriched civilization and was, thus, completed timely [4-5].

The Industrial Revolution, which commenced during the 18th Century, probably ought to have been designated "The Infrastructure Revolution". The Earth's bioshell has been variously impacted by anthropogenic advancements (*e.g.*, engineering works, urbanization, agriculture, forestry) over time and geographical space. Nowadays, industrial design and engineering are being increasingly accomplished by Generative AI. Naturally, most biogeophysical impacts of giga-projects occur during different phases of development. That is, environmental impactful modifications occur primarily after the completion (or decommissioning) of giga-projects as would be anticipated with the largest kind of technical system so far built by human civilization, distributing, and delivering specialized services, material and materiel, and assets to organizations, households, and corporations. Prudent observations dictate that most giga-projects in the Middle East must eventually be required to function during major dust and sandstorms, as well as the postulated impending increase in year-round ambient air temperature.

Corporate movie producers of Hollywood, Bollywood, or other entertainment industries elsewhere have not yet offered audiences the grand experience of a fictitious popular film depicting the dire effects of drought because it is simply not an entertaining geohazard-de-jour. Because drought cumulatively reduces national wealth increase while simultaneously induced large-scale human migration motivated by poor living and travel conditions (6-7), it lacks widespread public interest when human imaginations have difficulty coping with the vast adversities associated with persistent drought. In Britain, drought may have forced the switchover from stream-power to steam-power! The viability of many major watermill-powered industries in Britain were weakened by episodic post-1770 AD droughts and, thus, the European Industrial Revolution was a consequence, it is now theorized [8-9]. Early-2023, Dubai announced the prospective 93-kilometer-long roofed giga-project named "The Loop", a combination jogging, bicycling and walking pathway to protect users from desert heat as well as stormy weather.

Commercial films occasionally critique modern-day engineering and architectural projects. For example, Jacques Tati (1907-1982) offered ***Mon Uncle*** (1958) and ***Playtime*** (1967) both of which displayed entertaining comedy assessments of early-20th Century obsessions with kinetic motion and spare geometries [10]. Brazil's capital city, Brasilia (assembled 1956-1960), has long been assessed as a uniquely planned entirely new city composed of enormous modern-styled buildings set in a tropical jungle environment. Unfortunately, the expanse of pavement between buildings for arterial boulevards is so wide that pedestrians perceive them as heat sinks that cannot easily be traversed on foot. Turning to a middle latitude example in the desert Middle East, many people deride the vast concentrations of Arabian/Persian Gulf modern skyscrapers are as essentially "glassed refrigerators in the desert" [11].

However, the control of interior temperature and humidity in buildings is the basic reason for any kind of roofed architectural effort [12]. These types of modern edifices are not designed to be entirely practical but rather to influence human belief systems and cultural identity. Today, about 117 million people live in ecosystemcontrolled urban areas bordering the Gulf. Little appreciated is the prediction that Gulf climate change models indicate a marked near-term future warming and humidification of the air during the 21st Century. If these model predictions come to pass, outdoor physical labor will become problematic and almost intolerable, perhaps deadly [13]. If the environment becomes so harsh, as computer models predict, persons working outdoors will theoretically have to be encapsulated by non-pressurized body-chilling garments separating wearers from weather conditions. Such harsh environmental conditions would be demonstrably averse to good quality human health — certainly something more than still common female burqas and voluminous fabric male robes [14].

2 *Solvitur ambulando* ("it is solved by walking")

HRH Prince Mohammed bin Salman, on 25 October 2017, publicly announced a future for a unitary mirror-facade linear Saudi Arabian city-skyscraper, nicknamed "The Line." The proposal features topographical sitting atop the generally flat barren desert landscape approximately extending along the line of 28^0 North Latitude, starting slightly beyond the Gulf of Aqaba's seashore [15]. With His Royal Highness the Prince as its paladin, the NEOM giga-project (the NEOM acronym refers to a vision of a "New Future") is Saudi Arabia's most unique infrastructure development planning region to date, **Fig. 1**. "The Line" **Fig. 2**, is a term that refers to the resulting *walkable* linear city (described by the phrase "from any location in the structure just a 5-minute ramble to adjacent uncovered Nature"). NEOM's singular geographical feature [16], when completed, will perhaps eventually be tenanted by ~9,000,000 international residents. It will be connected by a paved extra-basement road and railway to the April 2016-proposed Saudi Arabia-Egypt Bridge intended by the Kingdom of Saudi Arabia and Egypt to span (via Tiran Island) the navigable entrance of the Gulf of Aqaba.

"The Line" (construction commenced during April 2022) will be a carless multi-module city-skyscraper. This significant structure will be approximately 0.2 km wide by 170 km long and will have an overall foundational ground footprint of about 34 square kilometers. Corridor-confined high-speed automated mass transit subways will connect the modular communities that will be situated intermittently along its length. Surely, that bodes future physical connection to places located beyond the terminals at both ends of "The Line." Its mapped ends, when extended imaginatively, intersect with the Arabian/Persian Gulf and the Gulf of Suez. In effect, "The Line" physically exemplifies the geopolitical concept of the *hinterland* where the inland landscape along the same line of latitude opens that interior landmass to habitation and industrialization [17]. With a non-pitted mirrored glass façade [18], "The Line" will reflect during summer 13 hours and 55 minutes of sunshine and 10 hours 22 minutes during winter and possibly even create a minimal windbreak-rain shadow effect! There is also the technical possibility the structure will be illuminated during nighttime like a billboard, possibly the world's largest! Although Saudi Arabia has ~10.8% of the USA's population, it has already initiated the expensive construction of a linked elements building where "The Line" is equal to ~0.04% of the USA's existing building floor space [19]!

Figure 1. General location of Saudi Arabia’s present construction of 26,500 square kilometer NEOM region development (Google Image).

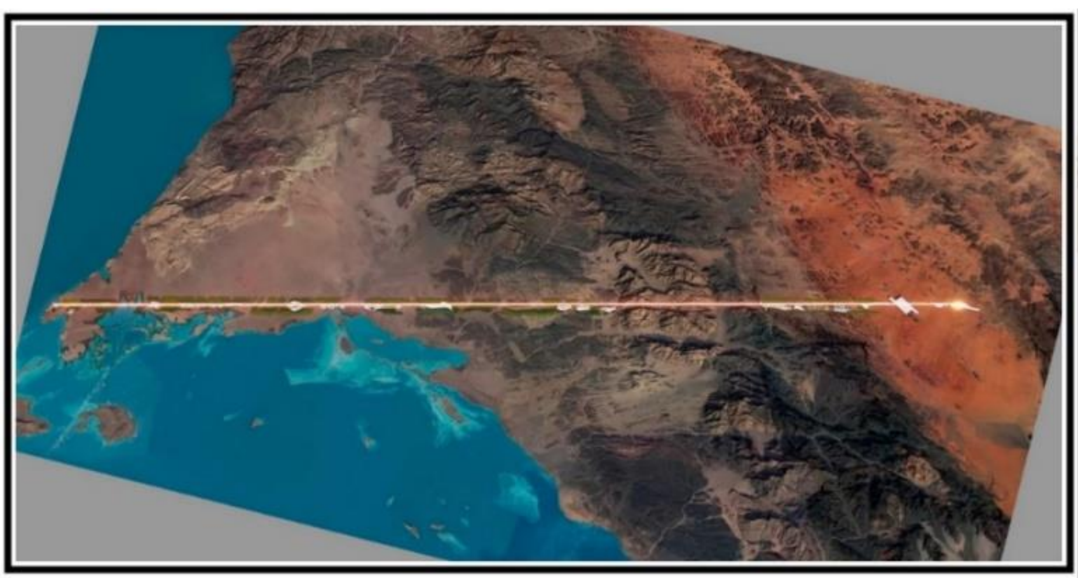

Figure 2. Extent of “The Line” envisioned as a part of world civilization set aside for those who wish to change regional Nature. Overlain on a satellite image of the dusty worksite resembles the 100-kilometer-long conveyer belt moving mined phosphate between Bou Craa and El Aaiun, Western Sahara. As a result of “The Line” ongoing ground excavation and disturbance of surficial materials associated with dunes and sandplains, dust storms are likely to occur. (Google Image redone by JMH).

Why “The Line” [20]? Prior to 1960, Saudi experience with the natural environment was mostly direct and, even for those acclimated to it, mostly uncomfortable. In effect, after the populace became commonly aware of doable architectural options to disconnect or protect from desert harshness, many sought to do so. As the Kingdom of Saudi Arabia endured rapid infrastructural upgrades, the most familiar element of which were industrial pipelines, its population became adjusted to the pleasantries of air-conditioned shopping malls, some of which were equipped with skybridges that enclosed pedestrian walkways linking two or more buildings at height. The module-cities spaced along the route could function as valves governing the flows of people, desalinated seawater [21], electricity, fuels, and manufacturing materials [22]. “The Line” is thus a symbolism-intense giga-project [23-25]. Although more substantial and imposing, “The Line” might be perceived as a semi-replication of ***The Running Fence*** artwork installed by Christo (1935-2020) across 40 km of a northern California coastal landscape during 1976 and which penetrated the Pacific Ocean a short distance [26]. The seaward most part of “The Line” is supposed to extend as a narrow, 500-meter-tall pier-settlement into the nearshore Gulf of Aqaba shallows! The linear form of spatial development is appropriated where the structure is used as a connecting element of more complex geographical installations [27].

3 Societal prolongations via exuberant elongated floating PV Magic Carpet giga-project

Perhaps the *next* essential Saudi Arabia linear giga-project planning region might well be the multi-nationally shared Arabian-Persian Gulf. The primal paradise, the idyllic Garden of Eden that is described in *The Bible*, may be submerged by ancient rises in sea-level where the 21st Century Arabian-Persian Gulf exists. Remnants of prior civilizations may be embedded in the seabed at its northern end [28], the central section [29] at its southern end [30], or even elsewhere [31]! The Mesopotamian marshlands lie mostly within southern Iraq and a part of southwestern Iran. Depending on the season, the marshes cover 1,100-2,800 square kilometers and are settled by the Ma’dan, or Marsh Arabs. People there sometimes still live on traditional woven artificial islands entirely fabricated from wild reeds, but in the past many more did so, perhaps since the 4th Millenia BC, and so its society forms today a vanishing cultural heritage. A disappearing cultural heritage (canonical heritage) often is assessed to be urgently preservable, while critical heritage is usually taken to mean a burden on those alive needing to be categorized as a threat to maintenance of social order. A sustaining perspective must be chosen if there is to be a long-term future for the Marsh Arabs. The 21st Century Ma’dan people fish and directly affect the northern Arabian/Persian Gulf’s commercial marine life, particularly shrimp (*Metapernaeus affinis*). Therefore, Kuwait and the Ma’dan people are economically networked and, thus, it may portend the Ma’dan become increasingly maritime labor; a future of living on seawater may not be such a radical shift from the way Ma’dan nowadays live, work, and play!

Climate change is a ubiquitous popular topic amongst vicinal dwellers of the Arabian/Persian Gulf. Yet, some geographical researchers expect Iran's Lut Desert, currently the world's hottest place during summer, to remain a viable commercial ecotourism attraction [32]. Along with meteorological drought and anthropogenically induced desertification, tropical cyclones seem to constitute a new natural hazard for the people and government of Iran, and perhaps others as well [33]. The probability of tropical storms occurring in the Arabian/Persian Gulf are allegedly "very low" [34]; yet, increasing surface seawater temperatures, driven by a warming regional climate as well as floating anthropogenic contaminants (from oil-spills [35], discharged sewage and industrial waste water) may induce conditions favorable to the perseverance of tropical cyclones therein. The Arabian/Persian Gulf, with an average depth of ~36 meters and a volume of ~8,630 cubic kilometers, is easily heated by enduring hot seasonal weather conditions [36]. Waves generated by tropical cyclones within the Arabian/Persian Gulf may not, however, exceed those measured in the North Sea. A pioneering offshore floating solar PV array rafting technology innovated and installed by the Zon-op-Zee Project on the North Sea remained intact during inclement conditions for several years, enduring winds of 62 knots and waves >5 m in height; the mats were designed to survive 10 m waves [37]! A generic floating Magic Carpet Giga-project can be summarized by the following components: (I) the float, (II) PV modules and their support, and (III) the associated electrical equipment. The float and its various necessary attachments tend to (I) attenuate wave action, (II) reduce normal and extraordinary solar irradiation, and (III) lower both ambient air and immediate contact seawater temperatures of the Arabia/Persian Gulf. Facts associated with such shadowing and moored or anchored stable devices was first completely determined by 2020 [38]. Of course, every necessary prospective mooring or anchorage would be thoroughly investigated via divers and/or bathy-drones [39].

Figure 3. The photovoltaic Magic Carpet giga-project, spanning ~5^0 of latitude and ~4^0 of longitude, shown here as a rectangular single architectural element, but which, when realized, will more likely not be one single floating base for

PV panels in order to accommodate shipping lanes as well as the clutter of existing offshore industrial facilities such as drilling and production oil-rigs. It is desirable that the array of floating PV mat-modules, the interlocked PV rafts, should be invisible to an adult human gazing seaward. Ultimately, it is possible that the rafts may coat ~24% of the Arabian-Persian Gulf surface. And, like Peru’s famed Nazca Lines, the “Magic Carpet” will finally attain the status of global tourist attraction, viewable too by Earth-orbiting space tourists. (Image courtesy of JMH).

Engineers, notably in Japan [40], have compiled many research findings about very large floating structures. Some of these floating electrical power generators include a single massive sailing solar-cell ocean-going raft with a functional area of 25 square km [41], or about 0.0417% of the proposed Magic Carpet Giga-project. Although automation of shipping is on-going, it is not yet fully conceived as a unitary means of transportation. Because effective IMO maritime safety regulations remain purely formational, proposed grandiose schemes for totally unmanned vessels sailing the world’s ocean and its many seaports may never be realized [42]. Also, shipbuilder’s dreams of hull coatings that prevent attachment of marine organisms has yet to materialize. Biofouling, however, often can be removed without dry docking using robotic hull cleaners. One of the most pressing potential macro-problems of the Magic Carpet Giga-project is aerial biofouling caused by annually migrating birds that use the Arabian/Persian Gulf as a flyway. Aerial drones can possibly be deployed to shoo nesting or resting birds from most vital raft segments containing warm solar panels! Dust and sand grains blown onto the raft from can be blown away at low cost from the aerial surfaces of the Magic Carpet using downdrafts from hovering rotorcraft drones [43-44].

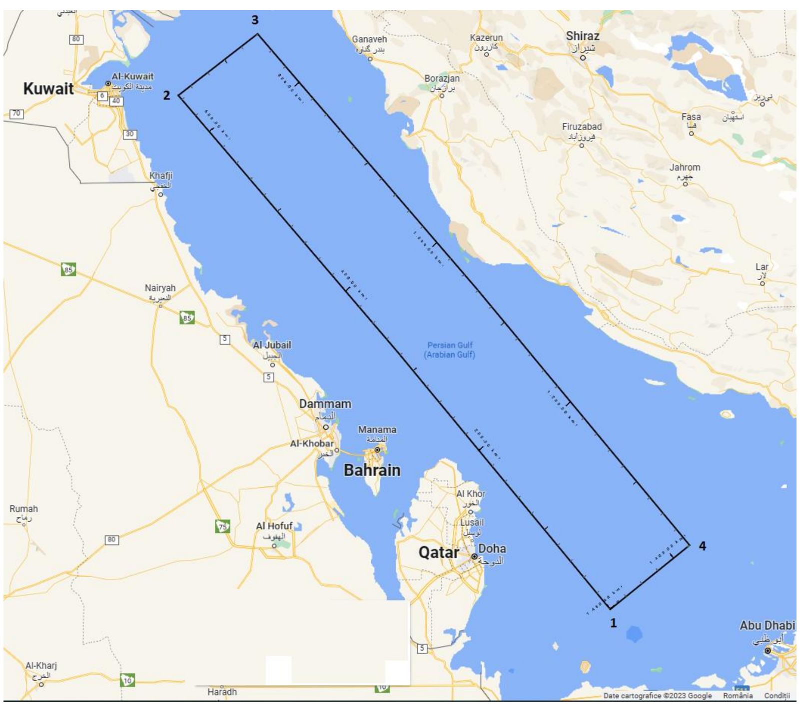

Figure 4. Hypothetic place of the PV power plant.

4. Magic Carpet Giga-project: PV solar-power generation calculations

4.1. Meteorological and radiometric data

The hypothetic field of PV modules covers the surface shown in Fig. A. The geographic coordinates of the corners of this figure are presented in Table A. The total surface of the field of PV modules is 62420.6 km^2.

Table 1. Geographic coordinates of the corners of the surface shown in Fig. 4.

Point number	Latitude (°N)	Longitude (°N)
1	24.8221	52.8469
2	29.2735	48.6575
3	29.7939	49.4266
4	25.3871	53.6170

Information about the air temperature and incident solar global irradiation is needed to estimate the performance of the PV power plant. Such kind of information may be found on the POWER platform. The NASA POWER Project provides meteorology, surface solar energy and climatology data for various needs: renewable energy, building energy efficiency and agricultural activities [45]. The surface solar energy data is freely available for download at a global scale with a spatial resolution of 1/2 by 1/2 arc degree longitude and latitude. The physical quantity extracted for this study is the All-Sky Insolation Incident on a Horizontal Surface (ALLSKY_SFC_SW_DWN). The solar radiation data provided by the POWER platform are taken from NASA's Global Energy and Water Exchanges - Surface Radiation Budget Project Release 3.0 archive and from NASA's CERES Fast Longwave and SHortwave Radiative Fluxes (FLASHFlux) project [46].

The monthly averaged values of the air temperature and incident solar global irradiation on a horizontal surface for the time interval 1984-2021 for all four points of Fig. 4 have been downloaded. Yearly averaged values have been computed for these two meteorological parameters (see Fig. 5). The air temperature slightly increases during the time interval 1984-2021, in good agreement with common perception that the air temperature has the tendency to increase on the whole global surface. Also, solar global irradiation shows a slight increasing tendency. The values of the air temperature, as well as those of solar global irradiation, in points 1 and 4 are close each other. This is to be expected, taking into account that the difference of latitude between the two points is small. A similar comment applies to the values of the meteorological parameters in points 2 and 3.

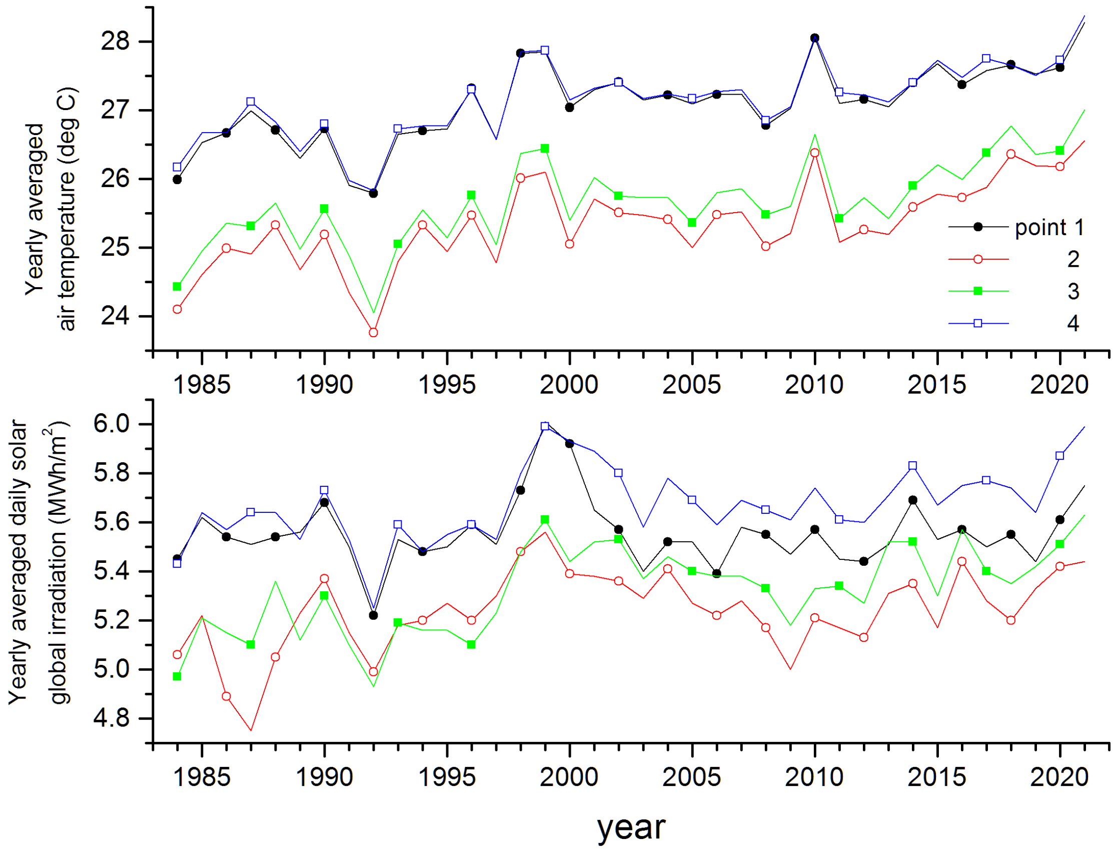

Figure 5. Yearly averaged values of air temperature and daily solar global irradiation on a horizontal surface during the time interval 1984-2021 for the four points of Fig. 4.

4.2. Evaluation of PV plant performance

The calculation procedure includes three stages:

1. Calculation of the monthly averaged efficiency of the PV cells and monthly averaged energy provided per unit surface area during the time period 1984 to 2021, in each of the four points that define the corners of the rectangular PV array;

2. Calculation of the surface averaged value of the monthly averaged daily energy provided by the PV array;

3. Calculation of the annual electrical energy provided by the whole rectangular PV array.

4.2.1. Calculation of the monthly averaged efficiency of the PV cell and monthly averaged energy provided per unit surface area

The calculation is performed for an opaque PV module (glass to Tedlar) with c-Si cells, with the structure shown in figure 6.

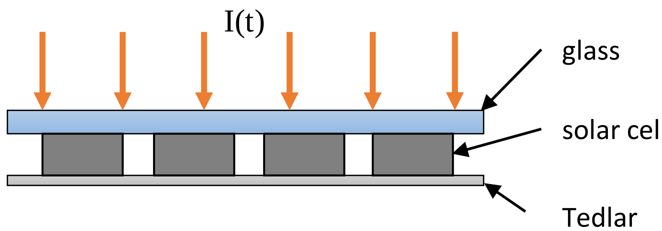

Figure 6. Cross section through opaque PV module.

The assumptions underlying the efficiency calculation are the following:

- the heat transfer from the PV cell to the environment is one dimensional;
- the PV module operates in quasi-steady state;
- resistive losses in the electrical circuit of the PV module are negligible.

The electrical efficiency of the PV cell, η_c, is obtained from the energy balance equation, taking into consideration the variation of efficiency with temperature [47]:

$$\eta_c(T_a, I) = \frac{\eta_{ref}\left[1-\beta_{ref}\left[(T_a(t)-T_{ref})+\frac{\tau_g[\alpha_c\beta_c+(1-\beta_c)\alpha_T]}{U_{Lm}}I(t)\right]\right]}{\left[1-\frac{\eta_{ref}\beta_{ref}\tau_g\beta_c}{U_{Lm}}I(t)\right]}, \qquad (1)$$

where $U_{Lm} = U_b + h_0$, with $U_b = \left(\frac{L_T}{K_T} + \frac{1}{h_i}\right)^{-1}$, and η_{ref} is the electrical efficiency of the PV module at the reference temperature, T_{ref} and at reference incident solar irradiance of 1000 W/m^2. The quantity β_{ref} is the coefficient of variation of efficiency with temperature. The values of these parameters are usually given by the PV module manufacturer. For opaque PV modules with c-Si cells, these values are as follows: $\eta_{ref} = 0.15$, $\beta_{ref} = 0.0041\ \frac{1}{K}$. at $T_{ref} = 25$ °C [47].

The design parameters of the opaque PV modules based on c-Si cells, to be used in Eq. (1), have the typical values shown in table 2.

Table 2. Parameters of opaque PV modules based on c-Si cells, to be used in Eq. (1) [48]

Quantity	Symbol	Units	Value
Solar cell absorptance	α_c	-	0.9
Temperature coefficient	β_c	-	0.89
Tedlar transmittance	α_T	-	0.5
Glass transmittance	τ_g	-	0.95
Heat transfer coefficient on top face of PV cell	h_0	$W/(m^2K)$	$5.7 + 3.8 \cdot v$
Heat transfer coefficient on bottom face of PV cell	h_i	$W/(m^2K)$	$2.8 + 3.0 \cdot v$
Thickness of Tedlar layer	L_T	m	0.0005
Thermal conductivity of Tedlar layer	k_T	$W/(mK)$	0.033

The values of the wind speed, v used to calculate the quantities h_0 and h_i in Table 2 are $v = 0.5\ m/s$ and $v = 0.2\ m/s$, respectively.

The electric efficiency of the photovoltaic cell, given by Eq. (1), depends on the ambient temperature, $T_a(t)$ and solar global irradiance, $I(t)$, which are functions of time. These functions may be estimated as time averages, such as hourly, daily, monthly or annual average values.

In this study, values of monthly averaged air temperature, $T(t)$ °C and monthly averaged daily global horizontal irradiation, $H(t)$ $\mathrm{kWh/m^2}$ were downloaded from the POWER database for the time period 1984 to 2021, for each of the four corners of the rectangular PV array. The data matrices provided by POWER were vectorized, resulting for each corner two column vectors, with 456 lines each (38 years x 12 months):

$T_{a,1_i}$ and H_{1_i} for point 1,

$T_{a,2_i}$ and H_{2_i} for point 2,

$T_{a,3_i}$ and H_{3_i} for point 3 and

$T_{a,4_i}$ and H_{4_i} for point 4, with $i = 1 \dots 456$.

Each vector contains the monthly values of the parameters $T(t)$ and $H(t)$ in chronological order, starting with 1984, continuing with 1985, 1986, 1987 until 2021. Each year the values correspond to the sequence of months: January, February, March to December. For example, the vector T_{a1} contains on the first row the temperature value of January 1984, on the second row the temperature value of February 1984, on the third one the temperature value of March 1984, and so on until the end of 1984. The next line contains the temperature value for the month of January 1985 and so on until line 456, where the temperature for the month of December 2021 is stored.

Next, the daily averaged solar global irradiance I(t) (in W/m^2) is computed from the daily solar global irradiation H(t) (entering in kWh/m^2) by using the relationship:

$$I = 1000\,\frac{H}{24}. \tag{2}$$

Further, the electrical efficiency of the PV cell at each point and each month was calculated using Eq. (1). This resulted in four column vectors, one for each point:

$$\eta_{c,1_i} = \eta_c\left(T_{a,1_i}, I_{1_i}\right) \text{ for point 1,} \tag{3}$$

$$\eta_{c,2_i} = \eta_c\left(T_{a,2_i}, I_{2_i}\right) \text{ for point 2,} \tag{4}$$

$$\eta_{c,3_i} = \eta_c\left(T_{a,3_i}, I_{3_i}\right) \text{ for point 3 and} \tag{5}$$

$$\eta_{c,4_i} = \eta_c\left(T_{a,4_i}, I_{4_i}\right) \text{ for point 4, with } i = 1 \ldots 456. \tag{6}$$

Finally, the electrical energy, P_c, provided daily per unit surface area of the PV cells was determined, in kWh/m^2, at each point and for each month:

$$P_{c,1_i} = \eta_{c,1_i} \cdot H_{1_i}\,, \tag{7}$$

$$P_{c,2_i} = \eta_{c,2_i} \cdot H_{2_i}\,, \tag{8}$$

$$P_{c,3_i} = \eta_{c,3_i} \cdot H_{3_i} \text{ and} \tag{9}$$

$$P_{c,4_i} = \eta_{c,4_i} \cdot H_{4_i},\ i = 1 \ldots 456. \tag{10}$$

Next, the values of the parameters are calculated as averages on the four points that define the rectangular PV array.

4.2. Calculation of the surface averaged value of the monthly averaged daily energy provided by the PV array

Surface averaged monthly values of air temperature, daily solar global irradiation, PV efficiency and electrical energy provided daily per unit surface area by the PV cells are calculated as arithmetic averages of the values corresponding to the four points as follows:

- surface average monthly air temperature,

$$T_{a,med_i} = \frac{T_{a,1_i} + T_{a,2_i} + T_{a,3_i} + T_{a,4_i}}{4},\ [^\circ C], \tag{11}$$

- surface average of monthly averaged daily solar global irradiation,

$$H_{\text{med}_i} = \frac{H_{1_i}+H_{2_i}+H_{3_i}+H_{4_i}}{4}, \left[\frac{\text{kWh}}{\text{m}^2}\right], \quad (12)$$

- surface averaged monthly PV efficiency,

$$\eta_{\text{c,med}_i} = \frac{\eta_{\text{c},1_i}+\eta_{\text{c},2_i}+\eta_{\text{c},3_i}+\eta_{\text{c},4_i}}{4} \text{ and} \quad (13)$$

- surface averaged electrical energy provided daily per unit surface area by the PV cells,

$$P_{\text{c,med}_i} = \frac{P_{\text{c},1_i}+P_{\text{c},2_i}+P_{\text{c},3_i}+P_{\text{c},4_i}}{4}, \left[\frac{\text{kWh}}{\text{m}^2}\right], i = 1 \ldots 456. \quad (14)$$

For the calculation of surface averaged electrical energy provided daily per unit surface area by the PV cells, the column vector *days* is defined, with 456 lines, containing the number of days corresponding to each month of the period 1984...2021. Thus, line 1 contains the value 31, representing the number of days in January 1984. The second line has the value 29 - the number of days in February 1984 (leap year). The third line contains the value 31, corresponding to March 1984 and so on, in chronological order. Line 12 contains the value 31, corresponding to December 1984. The next line contains the value 31, corresponding to January 1985. Line 14 contains the value 28, corresponding to February 1985 (normal year). The rest of the lines are completed similarly, in chronological order, until December 2021, considering leap years.

The electrical energy provided monthly by the PV array is calculated with the relationship:

$$E_{\text{med}_i} = P_{\text{c,med}_i} \cdot A \cdot \text{days}_i \ [\text{kWh}], i = 1 \ldots 456. \quad (15)$$

where $\text{A} = 62420.61\ km^2$ is the area of the rectangle defined by the four points, while days_i is the number of days in month *i*.

4.3. Calculation of the annual electrical energy provided by the whole rectangular PV array

The annual averaged values of air temperature, solar global irradiation, PV efficiency and electrical energy provided by the whole PV array are calculated, from 1984 till 2021, as arithmetic averages of the associated monthly values for each year.

It is noted with *j*, the index of the year of the time period 1984-2001, i.e. $j = 1 \ldots 38$, and two vectors *a* and *b* are defined, which contain the indices of the beginning and end lines of each year in the vectors $T_{\text{a,med}_i}$, H_{med_i}, $\eta_{\text{c,med}_i}$ and $P_{\text{c,med}_i}$, $i = 1 \ldots 456$:

$$a_j = 12(j-1)+1 \text{ and} \quad (16)$$

$$b_j = 12j. \quad (17)$$

For example, for $j = 1$, results $a = 1$ and $b = 12$,i.e. the first year, 1984, starts at line 1 (January) and ends at line 12 (December). The second year, 1985 ($j = 2$, $a = 13$ and $b = 24$) starts at line 13 (January) and ends at line 24 (December). Last year, 2021 ($j = 38$, $a = 445$ and $b = 456$) starts at line 445 (January) and ends at line 456 (December).

The averaged annual values of these quantities are calculated using the following relationships:

- annually averaged air temperature,

$$T_{\mathrm{a,med,year}_j} = \frac{\sum_{k=a_j}^{b_j} T_{\mathrm{a,med}_k}}{12} \; [℃], \tag{18}$$

- annually averaged daily solar global irradiation,

$$H_{\mathrm{med,year}_j} = \frac{\sum_{k=a_j}^{b_j} H_{\mathrm{med}_k}}{12} \left[\frac{\mathrm{kWh}}{\mathrm{m}^2}\right], \tag{19}$$

- annually averaged PV efficiency,

$$\eta_{\mathrm{c,med,year}_j} = \frac{\sum_{k=a_j}^{b_j} \eta_{\mathrm{c,med}_k}}{12}, \tag{20}$$

- annually averaged electrical power provided daily per unit surface by the PV cells,

$$P_{\mathrm{med,year}_j} = \frac{\sum_{k=a_j}^{b_j} P_{\mathrm{med}_k}}{12} \left[\frac{\mathrm{kWh}}{\mathrm{m}^2}\right], \; j = 1 \ldots 38. \tag{21}$$

The annual electrical energy provided by the whole PV array, during the time period 1984 to 2021, is obtained by summing up the electrical energy, generated in the twelve months of each year:

$$E_{med.year_j} = \sum_{k=a_j}^{b_j} E_{med_k} \quad [kWh], \quad j = 1,38. \tag{22}$$

4.4. Results

Figure 7 shows the yearly averaged values of several quantities during the time interval 1984-2021. The yearly averaged daily solar irradiation on a horizontal surface ranges between 5.1 kWh/m^2 in 1993 and 5.9 kWh/m^2 in 1999 (Fig. 7(a)). Therefore, the variation of the incident solar energy is around 13% during this 38-year interval. This should be compared with the variation of the electrical energy provided yearly by the PV plant which ranges between about 16250 TWh in 1993 and 18250 TWh in 1999 (Fig. 7(d)). The variation of the electrical energy provided yearly during the time interval 1984-2021 is about 10%. The difference between the two percent values is explained by the fact that the electrical energy provided by the PV plant is not directly proportional with the incident solar energy.

The yearly averaged air temperature increased from 25.6 °C in 1984 to 27 °C in 2021 (Fig. 7(c)). This means a difference of temperature of about 1.4 °C. The range of variation of the yearly averaged air temperature is even larger since the minimum air temperature was in 1993 (24.6 °C). The efficiency of the PV modules decreases by increasing the ambient air temperature. This is easily observed by comparing Fig. 7(c) with Fig. 7(b). The efficiency is minimum in 1999 and 2021, when air temperature reached its largest values.

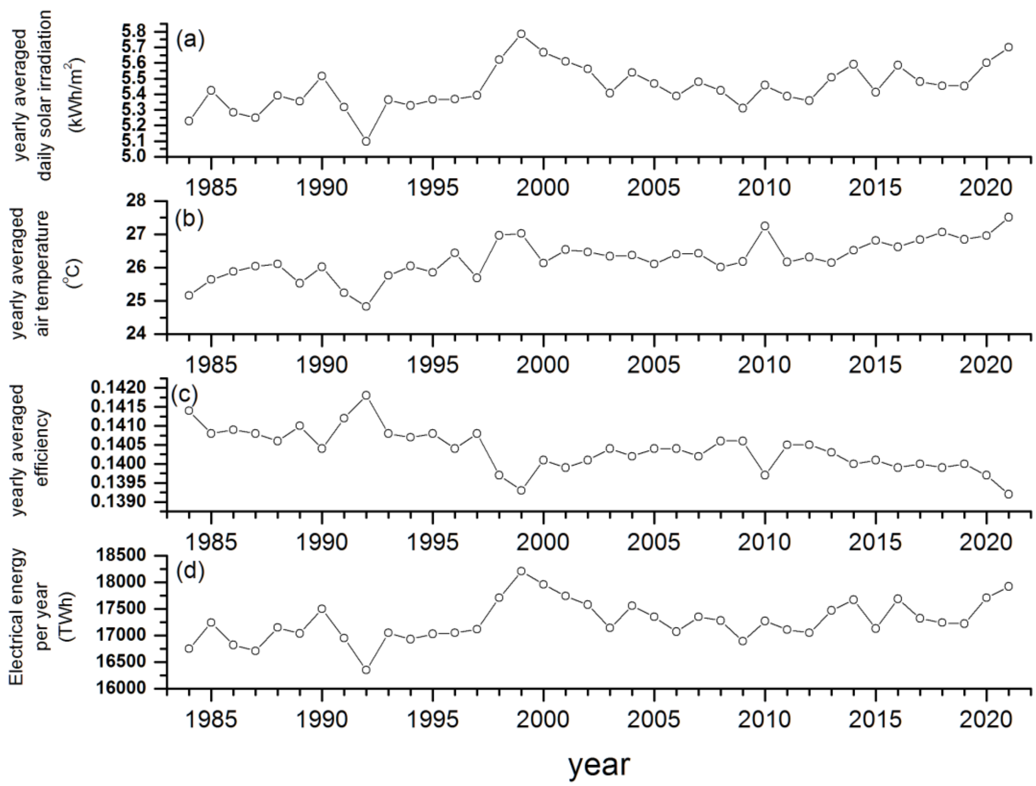

Figure 7. Yearly variation of several quantities. (a) Yearly averaged daily solar irradiation on a horizontal surface; (b) yearly averaged air temperature; (c) yearly averaged PV plant efficiency; (d) electrical energy provided yearly by the PV plant.

To give perspective to the present results, we may refer to the largest hydroelectric power plant operating on the Yangtze River at Yichang. Its installed power is 25000 MW. During 30 days months it generates about 16.2 TWh of electrical energy. The present PV plant will generate in June, in average, about 1800 TWh electricity, which means the equivalent of about 111 hydroelectric Yichang power plants. In December, the PV power plant has the smallest output, with 950 TWh of PV energy, which corresponds to about 58 hydroelectric Yichang power plants.

5. Desalination production of the Magic Carpet Giga-Project

Although Saudi Arabia has no permanent rivers, the essential technical configuration of "The Line" mimics a river in functionality. Since 2019, Saudi Arabia has operated the world's most productive desalinization plant, Ras Al-Khair, which manufactures ~1.4 million m3 of freshwater daily. Real-world observations as well as computer simulations show that the freshwater manufactory discharge brine alters the salinity of the whole Gulf as well as the Gulf's exchange seawater flows at the Hormuz Strait [49]. For northwestern Iran, its "locked-in" [50] degrading Lake Urmia. Due to areal contraction of the hyper-saline water area occurs because of a persistent regional drought, its 51,876 square km catchment is likely to become drier during the 21st Century [51]. Rather than enlarging Lake Urmia by importing costly desalinated water products from the Caspian Sea, a better result could be obtained using the Arabian/Persian Gulf Giga-project's PV-generated electricity: namely, by the cheaply pumped annual supply of ~10 cubic km of de-salted Gulf seawater to Lake Urmia via a long-distance pipeline. A similar overland piping system was previously proposed for southern California entailing the obvious potential for refilling of Utah's Great Salt Lake [52]. If this contriaved arid landscape installation seems like a lunatic renewal plan, it is perhaps appropriate to recall that Switzerland previously enrobed some of its skier-enjoyed mountainous landscape with vast swathes of geotextile sheeting to slow 21st Century glacial melt [53]. The potential volume of desalinated water producible by the proposed Magic Carpet would be in the hundreds of cubic kilometers!

6. Dilemmas, reflections, and all that about Geoengineering in the Gulf region

The last of the great utopias created was undoubtedly that of a cybernetic society, in which all individuals start to connect with each other virtually through digital space, or so-called "cyberspace". The obvious reasons this conceptual utopia failed are the fuel for the dystopia that is experienced now. An example of the lack of interpersonal communication resides in the fact that individuals from the same family, sitting side by side in an airport, prefer to communicate on cell phones via WhatsApp! A preponderant dystopian factor is the gradual replacement of science by technology such as AI (Artificial Intelligence), and, consequently, at the same time, the replacement of hope based on actions by the empty promise of an induced immediacy consumerism. In the wake of this cybernetic dystopia, all the technologies that today make use of cyber applications, such as medicine and engineering, have been developing. Doctors and engineers turn their problems over to machines, becoming less and less able to think. To what extent engineering will set aside its social value to let itself be guided solely by market parameters referring to awesome but superfluous cybernetic items is still unknown. But not everything is lost. Robotics associated with artificial intelligence brought real utilities in the form of more and more sophisticated drones, extremely useful in geoengineering. Nevertheless, greatest expectations of survival as a species rest on creative engineering, not as individuals, which seems to be more a role for medicine. It is from the use of renewable resources, the preservation of biomes, the desalination of seawater, and the hydration of deserts that permit human life to stay on Earth for a longer time. All of this is imagined based on large scale solutions which only the human mind can conceive.

Geoengineering, or macro-engineering, is the engineering way to find giant technological solutions to macro problems. Thinking of the arid Sahara and its extension in the Arabian Peninsula requires application of macro-imagination to make these regions more livable and productive in order to create more inviting spaces for people who have occupied during millennia its desert margins and oases. Persian Gulf nations, however, are among the most socially disparate countries on Earth, a fact that makes their true geopolitical intentions somewhat doubtful when they launch themselves into large projects. The great Muslim traditions, which in many ways constitute one of the most beautiful cultural expressions of humanity, have suffered extensive distortions over the centuries in favor of retrograde visions of totalitarian and exclusionary politics. This trend was subsidized in the 20th Century by the dominance of abundant fossil resources in the region and it is possible that the same domination may prevail over other sources of energy. Unfortunately, only the fundamentalism of the governing radical factions gains diffusion in the Western world, not allowing to show family ties, music and art in general of the truest branch of Sunni and the Sufi lineages (the latter constituting a contemplative and moderate form of Islam that opposes extremist and fundamentalist doctrines), and other minority branches whose interpretations of *Koran*, *Sharia* and *Suna* are more open. Even though Saudi Arabia is the most representative country of Sunni belief, and even with the partial Sufi emancipation granted in 2005 by the Saud prince at the time, later made King Abdullah, died January 23, 2015, guaranteeing them the right to practice the *dhikr* at home (the remembrance of God, with all the rites and gestures that characterize it), segregation and radicalism are still evident. It is not by chance that some dominant radical groups have prohibited access to the literature of Muslim writers such as Omar Khayyam (1048-1131), al-Ghazali (1058-1111) and Rumi (1207-1273), all of Sufi perception and much quoted by Western philosophers, writers and theologians. In a nutshell, until now, the House of Saudi and its acolytes from the Arab Emirates of the Gulf have shown in their pharaonic projects only a concern for modernity with a view to perpetuating the riches under their guardianship after the decline of oil, something that does not convince in the sense of social progress. In Qatar, for example, recent reports from a fellow correspondent show a sad scenario of exclusion, despite the image that was sought to be disseminated during the last Football World Cup. In this country, advanced refrigeration techniques, even in open environments, consume tremendous amounts of energy, but only for a privileged minority.

The big question is to ascertain who "The Line" is intended for (who were the artificial islands of Dubai intended for?). Large geoengineering projects, as the Magic Carpet Giga-project, are increasingly inevitable judging by the enormous survival needs for energy of populations that grow uncontrollably. In the not-too-distant future, it is possible that there will be a need for similar magic solar carpets in orbit in order to meet future energy demands. The question remains; however, will they be inclusive, or will they further increase inequalities? In a world of scarcity, considering that more than 2 billion people still cook using fuels that are harmful to health and the environment, it seems more likely that true human nature will prove to be ruthless. Thus, it is incumbent on society to call for global directions that include large investments in macro-engineering for the perspective of quality of life, which constitutes one of the guidelines of engineering and of architecture and urbanism. The model of the reigning Houses in the Gulf has never been permeated by this vision, and probably never will be, unless strong international geopolitical pressure convinces them that inclusion is the best way to avoid the mass evasion of human heritage due to climate crises that are to possibly come. No region in the world can sustainably support population overload, however open it might be to immigration. As a concrete case, the appalling human conditions in conflict zones at the Middle East have caused thousands of refugees to seek shelter in Europe, exerting unprecedented socio-economic pressure. It is in this scenario that geoengineering presents itself as a macro-instrument of survival and sustainability for all people.

7. Conclusion

Deserts are mature ecosystems with very low desirable productivity due to severe freshwater limitations prompted by natural and sometimes anthropogenic low-precipitation and high-evaporation conditions, according to *The Arid Lands: History, Power, Knowledge* (MIT Press, 2016) by Diana K. Davis. Interestingly, the application of aerial and orbital remote sensing technology to major desert and desertification studies only commenced *around* 1991 [54]. Some experts now suggest a comprehensive reorganization of human civilization's food-production by prioritizing optimal food-growing regions via mechanized farming and irrigation [55]. Before the 1950s, the Campo de Dalias, located in Spain's province of Almeria, consisted mostly of scrubby wild vegetation, some pastureland peppered by a few small plots of seasonal crops. Today, 400 square kms of southeastern Spain are covered by greenhouses! The advantage of indoor controlled air quality agriculture is that there are almost no requirements for pesticides and greenhouse crops use ~10% of freshwater normally needed by crops raised outdoors. Attended by drones [56], smart greenhouses in Qatar already produce healthy crops [57]. Realization of the Magic Carpet Giga-project could feasibly initiate a huge increase in the GDPs of Arabian/Persian Gulf ecosystem-states because of food and fiber exportation.

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Revista Brasiliense de Engenharia e Física Aplicada

Retractable Kinetic Towers Against Rocket

A Deployable Active Device to Monitor and React to Threats at Borders

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Received: _08 Feb 2023__/ Accepted: _16 Feb 2023__/ Published: _05 Apr 2023_

Resumo: Como alternativa aos drones, uma torre ativa movel pode ser facilmente içada, sendo capaz de operar de maneira equivalente a uma torre estática de vários quilômetros de altura, porém, com muito menos vulnerabilidades. Esta é uma aplicação do antigravitador de Bolonkin, um *framework* com dispositivos que fornecem uma força repulsiva (oposta à gravidade) entre determinados corpos. O conceito básico se resume em que um cabo forte e pesado é projetado para cima usando uma roda motorizada no chão. O impulso ascendente do cabo é transferido para o aparelho por meio de um mecanismo de polia/roldana, o qual leva o cabo de volta para o motor. O momento transferido do cabo para o aparelho produz uma força de empuxo que pode suspender o aparelho no ar, ou, simplesmente, levantá-lo. Há uma força igual e oposta na roda motorizada no chão. Este dispositivo é chamado de antigravitador cinético (repulsor cinético) porque a gravidade atrai quaisquer dois corpos, enquanto o dispositivo oferecido repele quaisquer dois corpos. Com a articulação correta, um estágio mais pesado pode suportar o mecanismo enquanto outro estágio mais leve se estende lateralmente como um braço dispondo uma ferramenta para realizar alguma tarefa. Essa torre é útil para comunicações, vigilância e ataque (incluindo lançamento de foguetes e disparos de canhão para alcance estendido em altitude), e pode ser rapidamente retraída e realocada. As "pipas de fogo" de Gaza e outras ameaças menos letais podem ser prontamente detectadas, antes mesmo de cruzarem a fronteira.

Palavras-chave: torre ativa, antigravitador, força repulsiva, transferência de momento.

Abstract: As an alternative to drones, a deployable active tower technology which appears to be an Indian rope trick, can suddenly place at height – the equivalent of a multi-kilometer tall tower with far fewer vulnerabilities than a static tower. This is one application of Bolonkin's antigravitator, a method and devices that provides a repulsive (repel, push, opposed to gravity) force between two given bodies. The basic concept is that a strong, heavy cable is projected upwards using a motorized wheel on the ground. The upward momentum of the cable is transferred to the apparatus by means of a pulley/roller mechanism, which sends the cable back down to the motor. The momentum transferred from the cable to the apparatus produces a push force which can suspend the apparatus in the air or lift it. There is an equal and opposite force on the motorized wheel on the ground. This device is called a kinetic (mechanical) antigravitator (kinetic repulsator) because gravitation attracts any two bodies, whereas the offered device repels any two bodies. With correct linkage one heavier stage can support the mechanism while another lighter stage reaches sideways like an arm to extend a tool to do a task. Such a tower is useful for communications, surveillance and strike (including rocket launch and cannon firing for extended range at altitude) and can be suddenly retracted and relocated. The "fire kites" of Gaza and other less lethal threats can be promptly detected and targeted in seconds at ignition before they ever cross the border. Similarly, rockets in boost phase of trajectory can be detonated from a distance of a few kilometers of a rocket launch. In addition, using this technology soldiers can "leap frog" to locations needed quickly and the "long arm" can extract those who pose a danger without endangering border control police or soldiers. Especially at night this would terrify those targeted.

Keywords: active tower, antigravitator, repulsive force, momentum transfer.

1 Introduction

Threats against the integrity of borders, such as the Gaza-Israel border, demand new technologies. Extant high-tech drones or low-tech walls have proven ineffective. To prevent border breaches or to react to impeding threats, a border must be continuously monitored. Currently, using conventional methods like satellite imaging and aerial photographs or videos has proven ineffective. Rather observation posts at a height are necessary: the higher you are, the farther you can see… but the farther they can see you.

Table 1: Distance to the Horizon

Height *h* (m)	**d_c (m)**	**Notes**
1	3,571.59	
1.5	4,374.29	Average eye-level
100	35,716.07	
1,000	112,948.13	
9,144	341,653.39	Aircraft cruising at 30,000 feet
100,000	1,133,855.37	The Kármán Line, or "edge of space"

Passive towers for observation usually take very long to construct, give warning a new observing post is coming into existence (and the enemy time to take countermeasures) and are increasingly vulnerable with the very height increase that make them useful. Collapses of TV towers, for example, can be sudden and dramatic. And while in theory a transporter/erector analogous to a missile launch vehicle could move and rapidly erect a very tall tower suddenly, it would be very difficult to engineer one with a reasonable mass fraction of payload.

Instead of using compressive tower engineering, this paper proposes a kinetic tower design of tensile tower engineering—tensioning fibers to support a load. Our invention is adapting the Kinetic Tower to an observe and attack instrument, a device just as a snake coils to a height before striking and launches the attack from its maximum height (Illustrated in Fig. 1) . The higher you are, the farther you can shoot…

The Kinetic Tower does not need to be raised until needed. When needed it:

- Rises like a periscope just above crest level
- Dips down, and computes a fire solution
- Up, confirm and correct for movement, fire for massively extended range (extra seconds of flight before hitting ground)
- down, and evasive action against counter-battery

- up, and counterstrike
- down, coil up, and hide in prepared hard site like a coiled snake

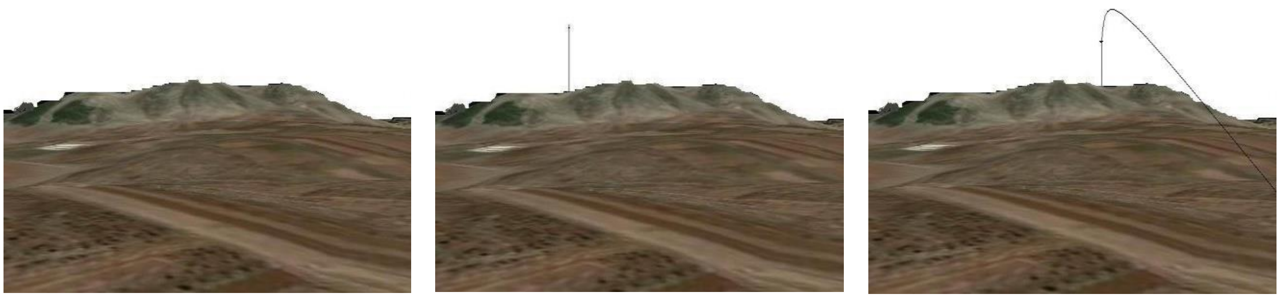

Fig. 1: Illustration of Kinetic Tower observe and strike capability.

Alexander Bolonkin has designed a kinetic tower [1- 8] capable of reaching height so great that you can literally have an elevator to space. [9 - 12] It is based upon the physics behind the uplift force of a pulley. It rises quickly and can be controlled. This method produces a push (repulsive, repel, opposed to gravitation) force between given bodies. The basic concept is that a strong, heavy cable is projected upwards using a motorized wheel on the ground. The upward momentum of the cable is transferred to the vehicle by means of a pulley/roller mechanism. This mechanism creates a push force and that also sends the cable back down to the motor. The momentum (push force) transferred from the cable to the vehicle can suspend it in the air or lift it. This force is equal and opposite to the force on the motorized wheel on the ground. The push (mechanical) force opposes the gravitational force between these bodies (for example, the ground and a flying vehicle). This force is created by a linear thin cable moved between the given bodies. If there is no roller and air friction and the distance between the given bodies is not changed, the suggested pusher does not require energy (except for the initial start and wheel friction). When the distance is increased, the energy is spent, when the distance is decreased, we gain energy. For some people this push force may be surprising because the bodies are connected only by the flexible thin long cable. But there are no violations of the laws of physics – we transfer a momentum between the bodies through the moving cable. When this momentum in a unit of time (force) is more than the gravity force, the bodies will move away from one other; when the momentum is less than the gravity force, the bodies will be drawn together.

In numerous papers and books Bolonkin demonstrated the feasibility of using a static fiber line to hold up a tower of taut lines. The dynamic forces to force a fiber structure is strong enough to rise erect into the sky, like an Indian rope trick. A practical truck mounted unit with its own deployable and rapidly relocatable tower with modular mounting points on top for payloads that can sense, strike, and defend is proposed in this paper.

This is ideal to observe enemy missile launches from a distance — and strike to prevent them, without expensive dedicated orbiting counter-strike aircraft. As such, this is a practical alternative to the Iron Dome which shoots down missiles before they hit the target: this can destroy the missiles before they are launched.

The whole point of a retractable tower is instant response capability. 5 km sideways strike range (2.5 km in each direction) is near optimum because then 20 towers can cover the Gaza border in real time. A different weapon head can be fitted to the kinetic tower to burn up fire kites. There are several approaches, but an infrared seeker head can detect the flames and guide a strike head to literally snatch the kite out of midair like a falcon. (Probably an easier approach to actually engineer is just to spray it with high pressure oxygen to make it burn itself out of the air over the Gaza Strip before it ever crosses the border, or to maneuver a small flamethrower using a Stihl liquid fuel pump within meters and burn the plastic up over the Gaza Strip from our side of the border and let *them* worry about putting out the fires, for a kinetic tower with the correct strike head can be based on our side of the border yet strike like a snake head.

Another possibility is using this device to levitate a soldier rapidly over the border to manually snatch a kite igniter or burn the kite itself up in the air with a flame thrower, or for other such rapid interventions. Especially at night, this would demoralize the enemy, because our soldiers would literally never set foot in Gaza yet be able to intervene at will. Positioning the baseline kinetic tower when and where it is needed is accomplished by a practical truck mounted unit with its own deployable and rapidly relocatable tower with modular mounting points on top for payloads that can sense, strike, and defend.

2 Method

Some variants of the installation are shown in Fig. 2. The installation includes (see notations in Fig. 2 and others): a linear closed-loop cable, top and bottom rollers, any conventional engine, and a load. Details of the top roller are shown in Fig. 3, the bottom (lower) driver roller is shown in Fig. 4. The small rollers (Fig. 4) press on the cable and together with the large roller and engine move the cable. The possible cable cross- section areas are shown in Fig. 4(c). Fig. 5 shows the anti-gravitator in a slope position. The installation includes (see notations in Fig. 2 (a), (b) and others): strong closed-loop cable, two rollers, any conventional engine, loop-top station, load elevator, and support stabilization ropes.

The installation works in the following way: the engine rotates the lower driver roller and continuously sends the closed-loop cable upwards at high speed. The cable reaches a top roller (which may be at high altitude), turns back and moves to the lower driver roller. When the cable turns back, it creates a push (repulsive, repel, reflective, centrifugal, momentum) force. This repulsive force can easily be calculated using centrifugal theory (see the theoretical section of this paper).

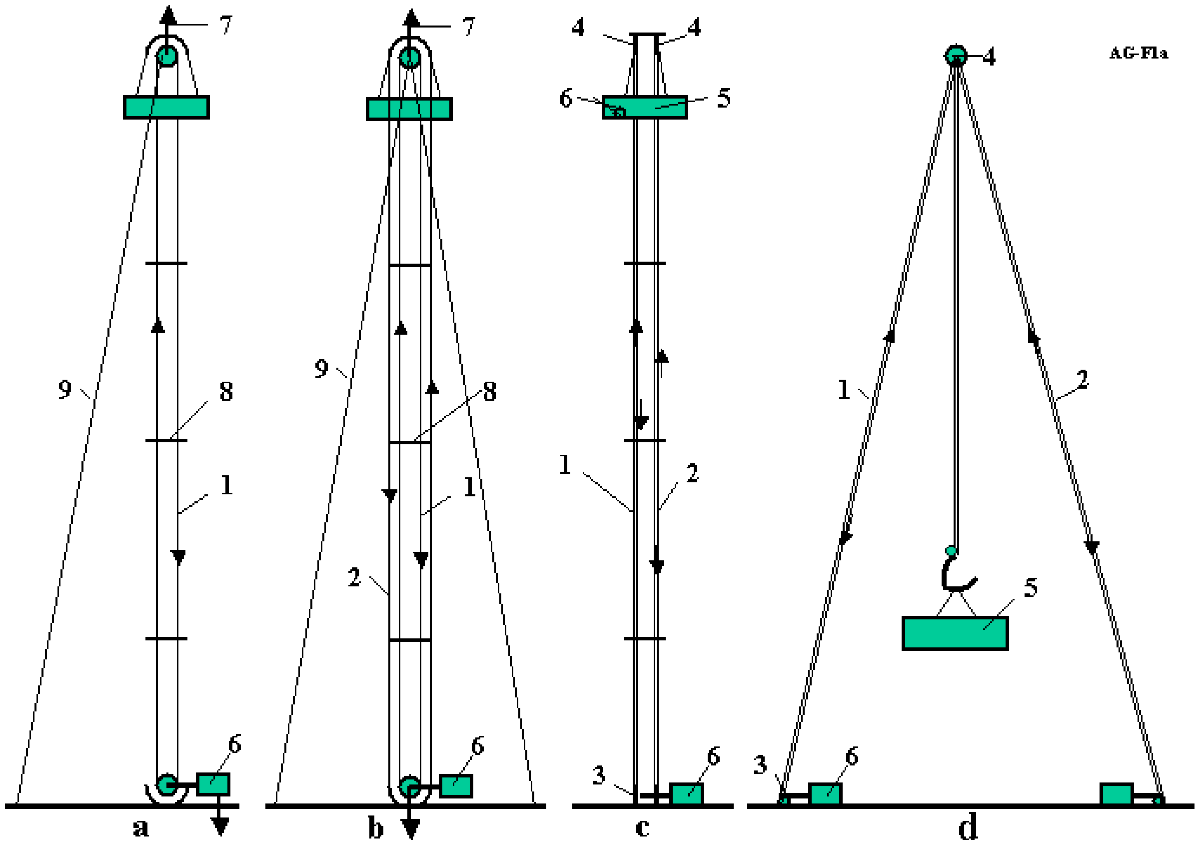

Fig 2: Push devices (kinetic anti-gravitators) with closed-loop cables. *a* – single cable with brace, *b* - double cables are moved in opposite directions and located in one plane, *c* – installation having four closed-loop cables in different plates and without braces, *d* – load crank having minimum three cables. Notation are: 1- one closed-loop cable; 2 – the second closed-loop cable; 3 – lower rollers; 4 – top rollers; 5 – suspended object; 6 – engine; 7 – push (lift) force; 8 – spreader, 9 - braces.

The push force can also be calculated against the mobile cable mass using momentum or reflection theories (see the theoretical section). The cable turns 180 degrees around pulleys. That turn produces a centrifugal force which supports or moves the load. However, Newton‘s laws say that for every action there is an equal and opposite reaction. In this case, the action comes from the wheel as this is what is pushing the cable and producing the net negative gravity field direction force on the cable. To do that, the wheel moves (is pressed) by the positive gravity direction. This means the cable will push the wheel back toward the source of the gravity (in this case to the ground).

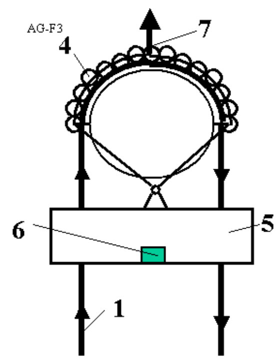

Fig. 3: Top roller of kinetic anti-gravitator (Notation: Same as in Fig. 2).

A top roller (Fig. 3) (which may be at high altitude), turns back and moves to the lower driver roller (Fig. 4). When the cable turns back, it creates a push (repulsive, repel, reflective, centrifugal, momentum) force. This repulsive force can easily be calculated using centrifugal theory. The push force can also be calculated against the mobile cable mass using momentum or reflection theories.

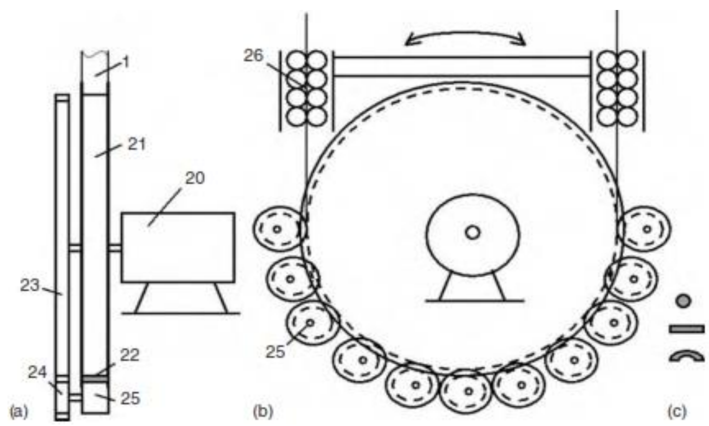

Fig. 4: Drive roller of kinetic anti-gravitator. Notations: (20) Engine; (21) drive roller; (22) (1) flexible cable; (23) large gear wheel; (24) small gear wheels; and (25, 26) directive rollers. (a) side view; (b) front view; and (c) cable cross-section.

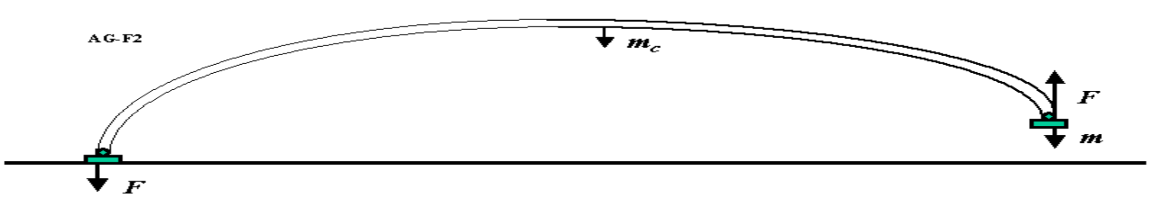

Fig. 5: Kinetic anti-gravitator in slope position.

The repulsive force points in a vertical direction and it must be more than the gravitational force of the cable and load. This anti-gravity force keeps the load or cable top station suspended on the top roller; and the load cable (or special elevator) allows the delivery of a load to the cable top station. The rollers and cable may have high speed and stress. They must be made from a strong (for example, composite) material. In this case, the rollers have the same permitted stress (and permitted rotary speed) as the cable. The permitted (safety assurance) speed (of the cable or roller) is the speed permitted (admitted, safety) by the maximum material strength divided by an assurance factor.

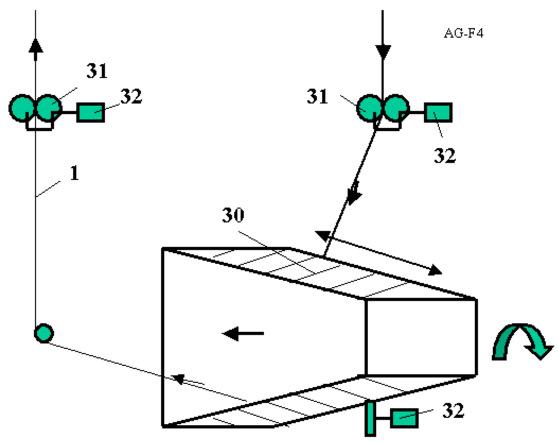

Fig. 6a: Revolving spool. Notations: (30) Cable spool; (31) directive rollers; and (32) spool engine. The left and right cables can have different speeds.

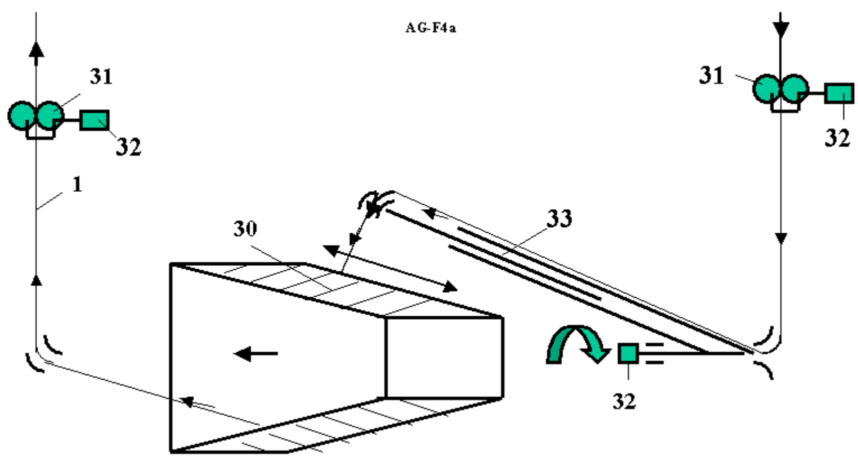

Fig. 6b: Motionless spool (the lever rotates around the spool). Notations: (30) Cable spool; (31) directive rollers; (32) motor; and (33) revolving lever. The left and right cables can have different linear speeds.

The moment of friction in the top roller can be compensated by guy lines as in Fig. 2(a), or by the second closed-loop cable rotating in an opposed direction to the first cable (Fig.2(b)–(d)) and located in one plane (Fig. 2(a)). A pusher may have its cable made from conventional steel wire (or steel fiber). This cable has a smaller permitted maximum speed and air drag. It requires less power for rotation than a light cable made from artificial fibers. As shown in the theoretical section, the current widely produced artificial fibers allow reaching altitudes of up to 100 km [2]. The closed-loop cable can be of variable length. This allows starting from zero altitude, increasing the load (station) altitude to a required value, and spooling the cable for repair. The devices for this action are shown in Figs. 6. The offered spools allow reeling and unreeling the left and right branches of the cable with different speeds to change the length of the cable.

3 Multi-stage kinetic tower.

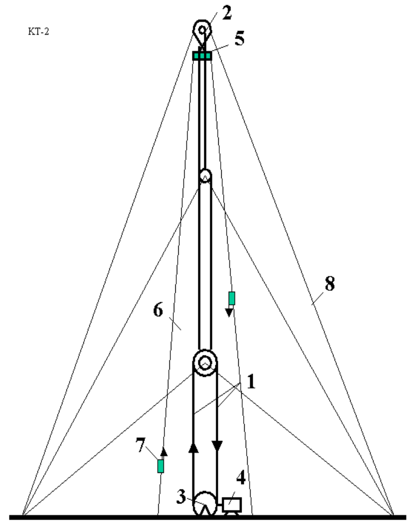

Fig.7: Multi-stage kinetic tower.

The offered tower may be used for a horizon parallel launch of cheap weapons like ballistic concrete or even rocks (Fig. 7). The vertical kinetic towers support horizontal closed-loop cables rotated by the first-stage vertical cables. The weapons apparatus is lifted by the vertical cable, then connected to the horizontal cable and accelerated to the required velocity — with a later model taller tower, even — above much of the atmosphere. This would enable a small missile to do the work of a huge missile because most of the fuel would not be wasted in the first and second stages. A cost factor of fifty times cheaper is possible. A horizontal device similarly can be used for launch aircraft or missiles. (Fig. 8)

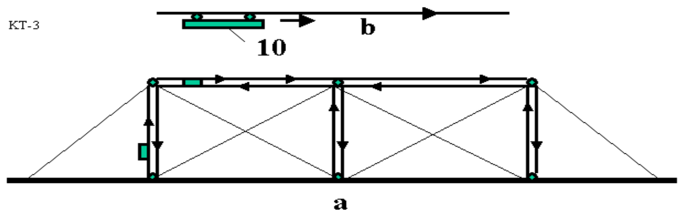

Fig.8: Kinetic space installation with horizon accelerate parts. *b.* 10 **-** Accelerated missile.

Advantages

The suggested towers and launch system have big advantages by comparison to the current solid towers and missile launch systems:

- They allow reaching a very high altitude impossible for solid towers. No expensive missiles or drones or fighter jets.
- They are cheaper by some thousand times than the current low towers. The kinetic towers may be used for tourism, power TV and radio transmission over a very large and profitable area, radio rf tag locator, as a space launcher.
- The offered kinetic tower launcher can be made in a few years. Other competing technologies may require some decades for development, design, and building.
- The offered cable towers and space launcher does not require high technology and can be made by any non-industrial country from current artificial fibers. Cables. Bolonkin details the parameters of cable characteristics in previous publications, for example, reference [13].
- Missile fuel brought to altitude is expensive just as jet fuel from an aerial tanker is more expensive than the same fuel on the ground. But the stationary loop-top station would allow economizing of the expense of pre-positioning this fuel, making possible refueling of drones at patrol altitude, and in fact replace drones because the engine is located on the Earth's surface and very powerful cameras and telescopes could be brought to an altitude of interest.
- Even expensive and delicate astronomical telescopes could be elevated above atmosphere and retrieved and maintained on the ground. For example, NASA's Kuiper Airborne Observatory (KAO) operates at 41,000 feet with powerful infrared telescopes.
- The fare for high altitude tourists would be affordable enough to open a massive new market.
- No pollution of the atmosphere from toxic rocket fuel. Conservation of drone engine flying hours.
- We can launch thousands of tons of useful loads annually.

- The capability of reaching vertical heights rapidly could be useful in skyscraper rescue and defensive works in mountain areas.

Mobility of the tower means rapid construction of defensive works is possible in an unprecedented way. For example, by means detailed [14, 15] Border communities, such as Sederot, could be given total ballistic protection against nearly any level of assault without needing to be on alert for incoming weapons. Kinetic towers could enable construction of standoff barriers (essentially nets with bags of small rocks that incoming missiles would have to hit) which would be impractical to build now but could be suspended in the air if kinetic towers could be used to wire cables above existing city geometry without using impractical conventional cranes. A conventional crane can take a good part of an hour to emplace but in theory a kinetic tower should be movable in real-time under computer control over a wider area of operation.

4 Theory of the kinetic anti-gravitator

Push force for immobile object

a) Repulsive (repel, push) force in space without gravitation**.** We can find the push force of the kinetic anti-gravitator from centrifugal theory (Fig. 9)

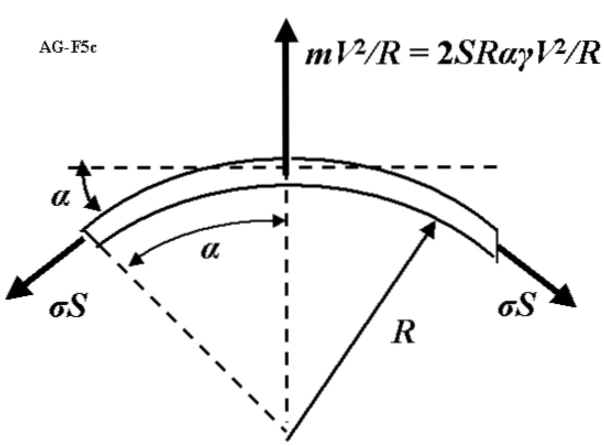

Fig. 9: Forces of the rotary circle cable.

We first take a small part of the rotary circle cable and write the equilibrium rotation for centrifugal force and tensile stress:

$$\frac{2SR\alpha\gamma V^2}{R} = 2S\sigma \sin\alpha \,, \qquad (1)$$

where α = angle of the circle part (in rad). When $\alpha \to 0$ the relationship between maximum rotary speed V and tensile strength σ of a closed-loop (curved) cable is

$$V = \sqrt{\frac{\sigma}{\gamma}} = \sqrt{k} \,, \quad F = 2\sigma S \,, \qquad (2)$$

where F is the repulsive (lift) force (N), $k = \sigma/\gamma$ is to relative cable stress (m^2/s^2), S is the area of one branch of the cable cross section (m^2). The more convenient value of $K = 10^{-7}k$ is used for graphs. For example, the cable has the cross-section area S = 1 mm^2, stress σ = 100 kg/mm^2. Two cables can keep a load of 200 kg at altitude. We can find the lift force using reflection theory (see textbooks on theoretical mechanics). Writing the momentum of the reflected mass in one second gives

$$F=mV-(-mV)=2mV,\ m=\gamma SV, \text{ or } \ F=2\gamma SV^2. \qquad (3)$$

Here, m is the cable mass reflected in one second (kg/s). If equation (2) is substituted into (3), the expression for the repulsive (lift) force $F = 2\sigma S$ will be the same.

b) Lift force in constant gravity field. In constant gravity field without air drag, the list force of the offered device equals the centrifugal force F minus the cable weight W

$$F_g = F - W = F - 2\gamma gSH = 2\gamma S(V^2 - gH) = 2S(\sigma - \gamma gH) = 2S\gamma\left(k - gH\right) \,, \qquad (4)$$

where H is the height of the kinetic device (top end of the cable) (m).

c) Repulsive force for a mobile object. For a mobile object the repulsive force is

$$F = 2\gamma S\,(V \pm v)^2 \,, \qquad (5)$$

where v is the objective speed [m/s]. The minus sign is taken when the cable length is increased, the plus sign is taken when the cable length is decreased. From equation (5) it follows that the maximum object speed obtained from the cable cannot exceed the cable speed. Equation (5) is used for launching and landing of flight apparatus.

d) Restore force**.** When the cable is deviated from a vertical position in the gravity field, the restore force is

$$F_r = F - g\, m_c/2 \,. \qquad (6)$$

5. Air drag of the cable

The computation of cable drag is not developed. No experimental data are available for air drag of a very long cable.

a) The air drag of a double subsonic cable can be estimated using the drag equations for plates (the Reynolds number is included) [16]

$$D_L = 0.5 \cdot 0.664\rho^{0.5}\mu^{0.5}V^{1.5}L^{0.8}s,\ D_T = 0.5 \cdot 0.0592\,\rho^{0.8}\mu^{0.2}V^{1.8}L^{0.8}s, \quad D = 0.5(D_L + D_T) \qquad (7)$$

The cable has only one side, as opposed to a plate which has two sides, that way the multiplier 0.5 is inserted (Fig. 10 and 11).

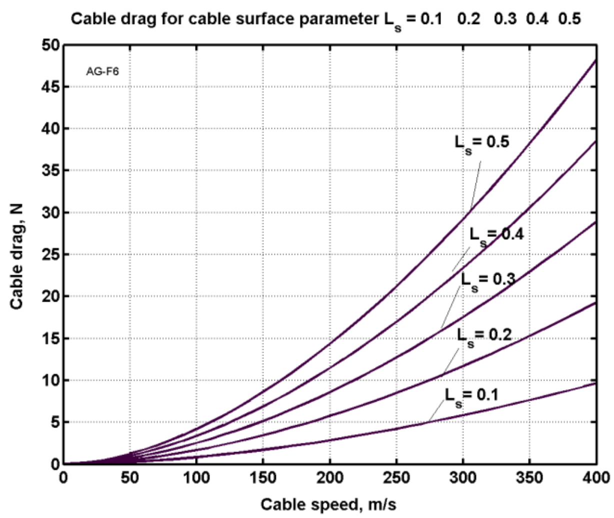

Fig. 10: Air cable drag versus cable speed for the cable surface parameter $L_S = L^{0.8}\ s = 0.1– 0.5$.

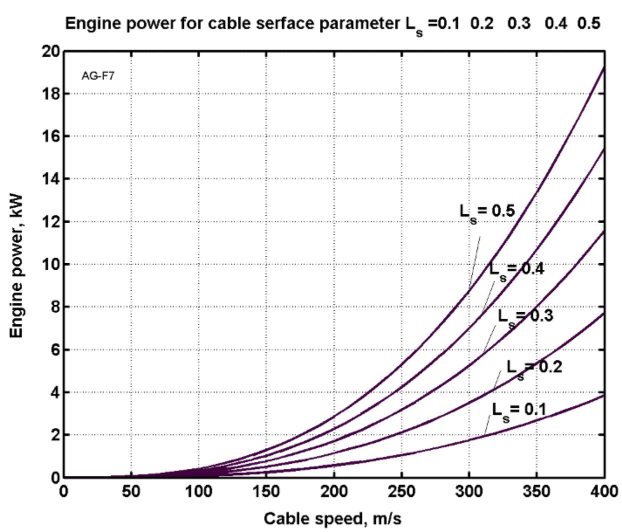

Fig. 11: Engine power versus cable speed for the cable surface parameter $L_S = L^{0.8}\ s = 0.1– 0.5$.

The power P of cable air drag D is

$$P = DV = 0.5(D_T V + D_L V) = 0.5(P_T + P_L), \quad V = \sqrt{\sigma/\gamma} \ . \tag{8}$$

The power of turbulent drag P_T and of laminar drag P_L, respectively is

$$P_L = 0.5 \cdot 0.664 \rho^{0.5} \mu^{0.5} \left(\frac{\sigma}{\gamma}\right)^{1.25} L^{0.8} s, \quad P_T = 0.5 \cdot 0.0592 \rho^{0.8} \mu^{0.2} \left(\frac{\sigma}{\gamma}\right)^{1.4} L^{0.8} s, \tag{9}$$

where the total cable perimeter s of the round cables is

$$s = 2\sqrt{\frac{\pi n F}{\sigma - \gamma g H}} \ . \tag{10}$$

Most of the engine power (80– 90%) takes the turbulent cable drag. In space there is no air, thus no air drag and we can use a very long cable. If the altitude H is small (up to 5 – 6 km), we can ignore the factor $\gamma g H$. In this case, the cable depends on the relation ($\sigma^{0.9}/\gamma^{1.4}$). As you see, a cable with low tensile stress σ and high density γ (for example, conventional steel cable) requires less power because the safe maximum cable speed is small ($V \approx 250$ – 350 m/s). However, the required cable weight increases 10 – 15 times. The round and single closed-loop cable (n = 2) requires minimum power. The plate and semi-circle cables require more power, but they may be more suitable for a drive mechanism.

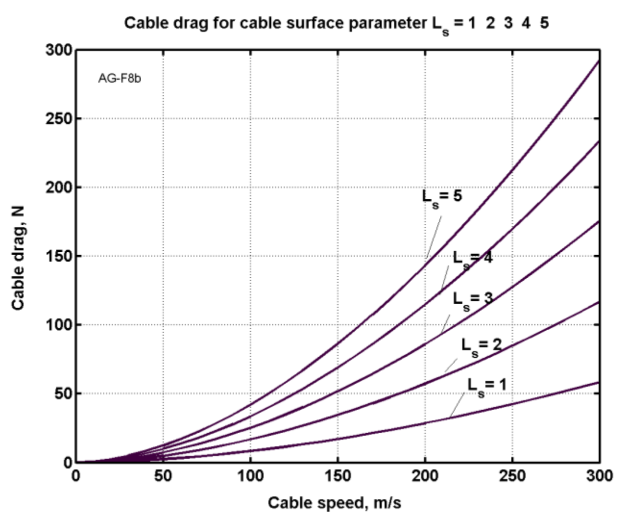

Fig. 12a: Cable drag versus cable speed for the cable surface parameter $L_s = L^{0.8} s$ = 1– 5.

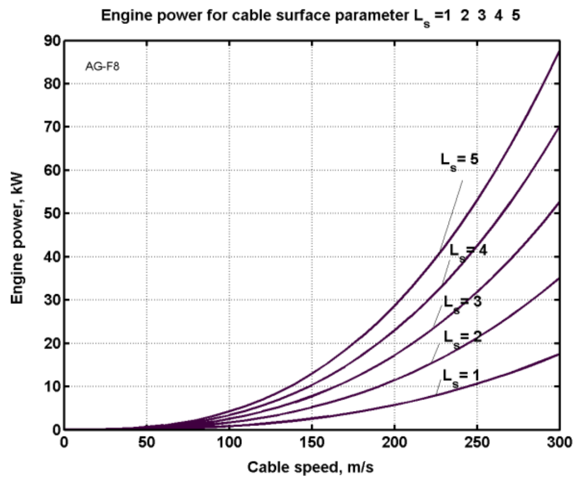

Fig. 12b: Engine power versus cable speed for the cable surface parameter $L_s = L^{0.8}\, s$ = 1– 5.

b) Air drag of supersonic and hypersonic double cable. Below, the equation from Anderson[6] for the computation of local air friction for a two-sided plate is given.

$$\frac{T^*}{T} = 1 + 0.032M^2 + 0.58\left(\frac{T_w}{T} - 1\right), \quad M = \frac{V}{a}, \quad \mu^* = 1.458\times10^6\,\frac{T^{*1.5}}{T^* + 110.4},$$
$$\rho^* = \frac{\rho T}{T^*}, \quad R_e^* = \frac{\rho^* V x}{T^*}, \quad C_{f,L} = \frac{0.664}{(R_e^*)^{0.5}}, \quad C_{f,T} = \frac{0.0592}{(R_e^*)^{0.2}},$$
$$D_L = 0.5C_{f.l}\rho^* V^2 S, \quad D_T = 0.5C_{f.t}\rho^* V^2 S, \quad D = 0.5D_T + 0.5D_L, . \tag{11}$$

Where[6]: T^*, Re^*, ρ^*, μ^* are the reference (evaluated) temperature, Reynolds number, air density, and air viscosity respectively. $M = V/a$ is the Mach number, a is the speed of sound (m/s), V is cable speed (m/s), x is the length of the plate (distance from the beginning of the cable) (m), T is flow temperature (°K), T_w is body temperature (°K), $C_{f.l}$ is a local skin friction coefficient for laminar flow, $C_{f,t}$ is a local skin friction coefficient for turbulent flow. As S is the area of skin (m^2) of both plate sides, it means for the cable we must take 0.5S; D is the general air drag (friction) (N). It may be shown that the general air drag for the cable is $D = 0.5D_T + 0.5D_L$, where D_T is the turbulent drag and D_L is the laminar drag. For a **horizontal** cable, the friction drag can be computed using equation (8) where $\rho = \rho^*$, $\mu = \mu^*$. From equation (11) we can derive the following equations for turbulent and laminar boundary flows of a **vertical** cable

$$D_T = \frac{0.0592s}{4}\rho_0^{0.8}\left(\frac{T}{T^*}\right)^{0.8}\mu^{0.2}V^{1.8}\int_{H_0}^{H} h^{-0.2}e^{0.8bh}dh = 0.0547d\left(\frac{T}{T^*}\right)^{0.8}\mu^{0.2}V^{1.8}\int_{H_0}^{H} h^{-0.2}e^{0.8bh}dh,$$
$$D_L = \frac{0.664s}{4}\rho_0^{0.5}\left(\frac{T}{T^*}\right)^{0..5}\mu^{0.5}V^{1.5}\int_{H_0}^{H} h^{-0.5}e^{0.5bh}dh = 0.5766d\left(\frac{T}{T^*}\right)^{0.5}\mu^{0.5}V^{1.5}\int_{H_0}^{H} h^{-0.5}e^{0.5bh}dh, \tag{12}$$

where s is the cable perimeter. The laminar drag for high speed is 50–300 times less than the turbulent drag and we can ignore it. Engine power and additional cable stress can be computed using conventional equations:

$$P = 2DV, \quad \sigma = \pm\frac{D}{S} = \pm\frac{4D}{\pi d}, \tag{13}$$

The factor 2 is needed because we have two branches of the cable: one moves up and the other moves down. The drag does not decrease the repulsive (lift) force because in the different branches the drag is in the opposite directions. Computations of equation (6) are presented in Figs. 10 to 12 for low cable speeds and in Fig. 13 and 14 for high cable speeds for different value $L_s = L^{0.8} s$.

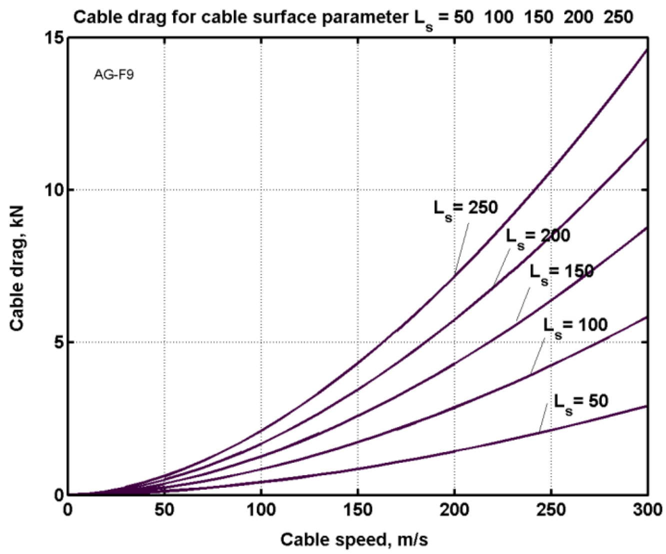

Fig. 13: Air cable drag versus cable speed for the cable surface parameter $L_s = L^{0.8} s$ = 50–200.

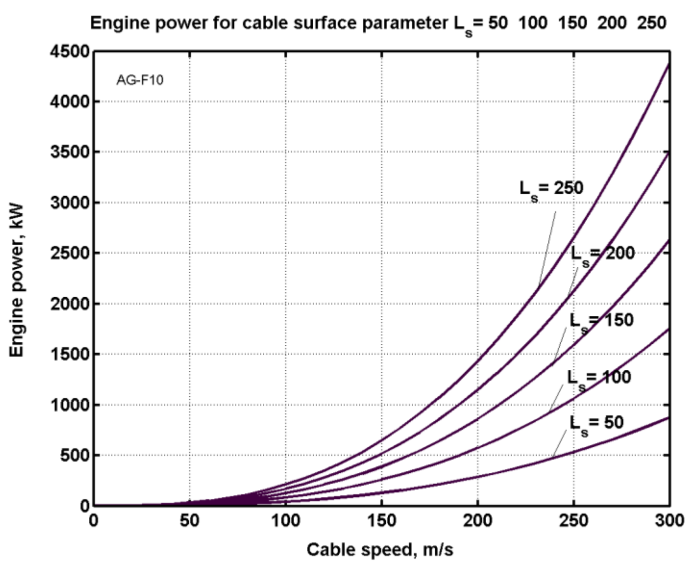

Fig. 14: Engine power versus cable speed for the cable surface parameter $L_s = L^{0.8} s$ = 50–200.

6. Limitations Contingent Upon Wind

Wind: speed, duration, altitude distribution, speed distribution

Wind is important element of the offered method. The wind vortexes from buildings and trees are located at near Earth surface. We can calculate the minimum and maximum admissible wind for the kinetic tower.

$$\frac{dH}{dV}=-V,\quad \frac{dV}{dt}=g-\frac{D}{m},\quad \frac{D}{m}=C_D\frac{\rho aV}{2p},\quad p=\frac{0.5C_D\rho aV}{gN},\quad p\geq 0,\quad \frac{D}{mg}\leq N,$$
$$for\quad H=0-10km\quad \rho=1.225e^{-H/9218},\quad for\quad H=10-\infty\quad \rho=0.414e^{-(H-10000)/6719}, \qquad (14)$$

where H – altitude (m), V – speed (m/s), t – time (sec), m – mass (kg), D – drag (n), g =9.81 m/sec^2 – gravity, C_D – drag coefficient, ρ - air density (kg/m^3), a – sound speed (m/sec), p – parachute specific load (kg/m^2), N – overload (g).

Wind speed increases with height. The speed may be computed by equation

$$\frac{V}{V_0}=\left(\frac{H}{H_0}\right)^{\alpha}, \qquad (15)$$

where V_0 is the wind speed at the original height, V the speed at the new height, H_0 the original height, H the new height, and 〈 the surface roughness exponent (Table 2).

Table 2: Typical surface roughness exponents for power law method of estimating changes in wind speed with height [17]

Terrain	Surface Roughness Exponent, α
Water or ice	0.10
Low grass or steppe	0.14
Rural with obstacles	0.20
Suburb and woodlands	0.25

The result of computation of equation (15) for different heights is presented in Fig.15. The wind speed increases on 20-50% with height.

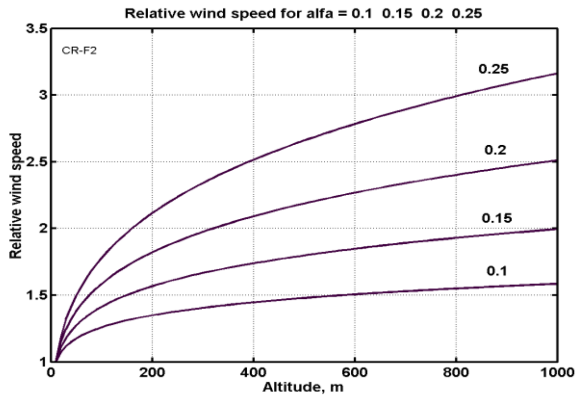

Fig.15: Relative wind speed via altitude and Earth surface. For sea and ice α = 0.1**.**

Annual Wind speed distribution

Annual speed distributions vary widely from one site to another, reflecting climatic and geographic conditions. Meteorologists have found that the Weibull probability function best approximates the distribution of wind speeds over time at sites around the world where actual distributions of wind speeds are unavailable. The Rayleigh distribution is a special case of the Weibull function, requiring only the average speed to define the shape of the distribution.

Equation of Rayleigh distribution is

$$f_x(x) = \frac{x}{\alpha^2}\exp\left[-\frac{1}{2}\left(\frac{x}{\alpha}\right)^2\right], \quad x \geq 0, \quad E(X) = \sqrt{\frac{\pi}{2}}\alpha, \quad Var(X) = \left(2 - \frac{\pi}{2}\right)\alpha^2, \qquad (16)$$

where α is parameter, is illustrated in Figs. 16 and 17.

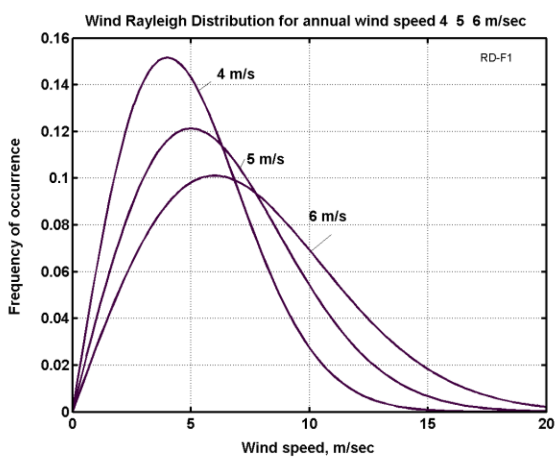

Fig. 16: presents the annual wind distribution of average speeds 4, 5, and 6 m/s.

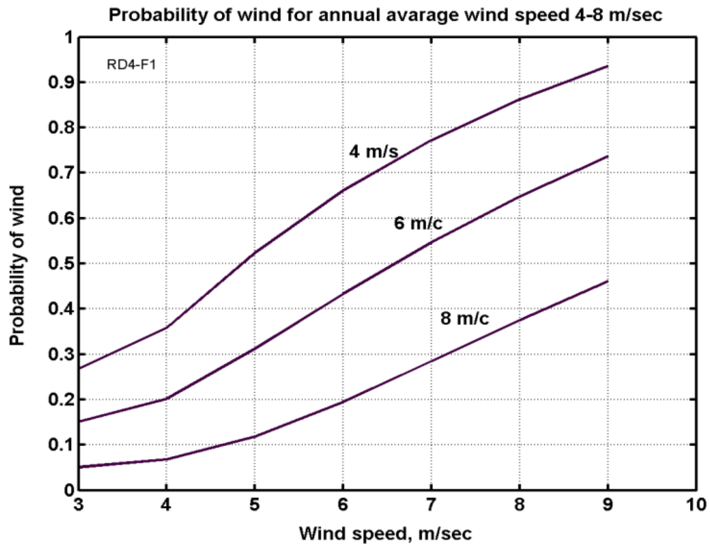

Fig. 17: Wind speed distribution**.**

7. Viewing Distance (distance of video signal)

The distance L which can be viewed of the Earth from a high altitude (antenna) is given by

$$L = \sqrt{2R_e H + H^2}\,, \tag{17}$$

where R_e = 6378 km is the Earth radius, H is an antenna altitude. The results of computation show that video signal in distance of hundreds of times more than current MAV, which has range only 0.3 – 1 km).

8. Mass and Admissible Current of Wire

The admissible current in wire depends from relation a gross-section area to a cooled wire surface. That why it linearly depends upon diameter of wire. For aluminum and copper wire these ratios are following respectively:

$$J_1=8d, \quad J_2=10d\,, \tag{18}$$

where J_1, J_2 are admissible current (ampere), d is wire diameter (mm). Result of computation is in Fig.18.

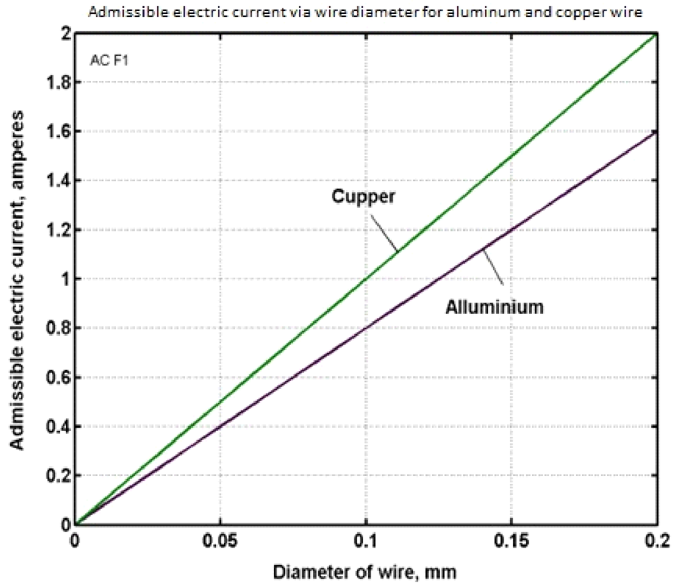

Fig. 18: Safe electric current via wire diameter for aluminum and copper wire.

The weight, W (g) of wire is respectively

$$W_1 = \frac{\pi}{4} d^2 \gamma_1 L \,, \quad W_2 = \frac{\pi}{4} d^2 \gamma_2 L \,, \tag{19}$$

where d is wire diameter (cm), γ - density (g/cm^3), L is a wire length (cm). For aluminum γ = 2.7 g/cm^3, for copper γ = 8.93 g/cm^3. The result of computation for L = 100m is presented in Fig. 19.

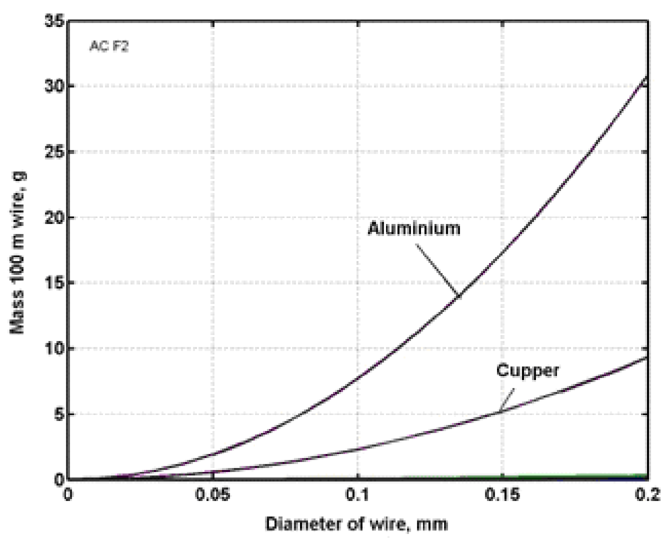

Fig. 19: Mass of 100 m aluminum and copper wire + 10% of wire cover (isolator), g.

9. Kinetic tower of height 4 km and variants for security applications

Take a conventional artificial fiber widely produced by industry with cable performances as follow: admissible stress is σ =180 kg/mm^2 (maximum σ = 600 kg/mm^2, safety coefficient n = 600/180 = 3.33), density is γ = 1800 kg/m^3, cable diameter d =10 mm.

The special stress is $k = \sigma/\gamma = 10^6$ N/m^2 ($K = k/10^7 = 0.1$), admissible cable speed is $V = k^{0.5}$ =1000 m/sec., the cable cross-section area is $S = \pi d^2/4$ = 78.5 mm^2, useful lift force is $F = 2S\gamma(k\text{-}gH)$ = 27.13 tons; requested engine power is P = 16 MW (Eq.(10)), cable mass is $M = 2S\gamma H = 2 \cdot 78.5 \cdot 10^{-6} \cdot 1800 \cdot 4000$ = 1130 kg.

The variants

a) Flying "superman" (Fig. 20a). Taking on altitude H = 100 m, the maximum load is M = 200 kg (this is enough for superman, his equipment, an engine and a parachute for safety). The steel cable has cables is $S = Mg/\sigma$ = 2 mm^2, cable diameter is d = 1.6 mm, the perimeter of the four cables is s = 10 mm. The cable mass is $m = SL\gamma$ = $2\times10^{-6}\times100\times7800$ = 1.56 kg, and cable speed is $V = \sigma / \gamma = 10^9 \; 7900$ = 356 m/s. Area parameter is $L_S = L^{0.8}s$ = $100^{0.8} \; 0.01 = 0.4$. The cable drag is D = 31 N (Fig. 10 or equations (9) – (10)), and the required engine power is P = 11 kW (Fig. 11). The cable can be made from transparent fibers and in any case it will be invisible from a long distance.

b) Walking "superman" or vehicle (Fig. 20b). The lower rollers can be made separately and have separate controls. This allows the supermen to walk, run, and move with high speed. For example, if the previous flying superman described above takes one step (length 100 m) in 2 seconds, he will have a speed of 180 km/hour.

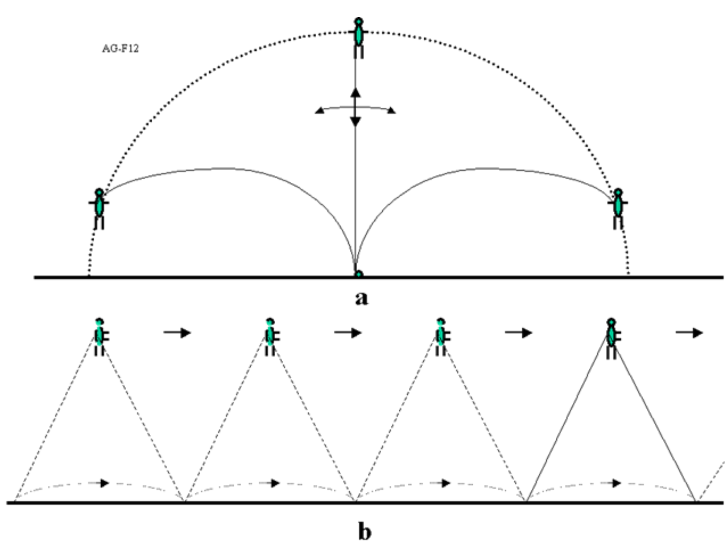

Fig. 20a: Flying superman using the kinetic anti-gravitator. b) Legged (walking) superman using two kinetic anti-gravitators.

c) Jumping (pogo-stick) "superman" (Fig. 21a). Assume the short kinetic anti-gravitator gives a man of mass M = 100 kg the speed V = 70 m/s with acceleration $a = 3g$ = 30 m/s^2. The cable length is $L = V^2/2a = 70^2/2\times30$ = 82 m. The time of acceleration $t = V/a$ = 70/30 = 2.33 seconds. The total cross- section areas of all cables is $S = Ma/\sigma$ = 100×30/200×10^7 = 1.5 mm^2, and the cable mass is $m = SL\gamma$ = 1.5×10^{-6} × 82 × 1800 = 230 g. The jump distance at an angle α = 45° without air drag (it is small at this speed) is $J = V^2/g$ = 70^2/10 = 490 m, the altitude is $H = V^2\sin\alpha/2g$ = 70^2 sin 45°/20 = 173 m, jump time is about 10 seconds. The required starting thrust is 300 kg, and the start (jump) power is about $P = E/t = mV^2/2t$ = 100 × 70^2/2 × 2.33 = 105 kW, but the start energy will be restored in landing except for the air drag loss of 10–20%. If we have an energy accumulator, a permanent power of 5 –10 kW will be enough for this device.

d) Jumping vehicle. Assume the kinetic anti-gravitator gives a vehicle of mass M = 1000 kg the speed of V = 200 m/s with acceleration $a = 8g$ = 80 m/s^2 (which is acceptable for military soldiers). The cable length is $L = V^2/2a$ = 200^2/2/80 = 250 m. The time of acceleration $t = V/a$ = 2.5 seconds. The jump distance at an angle of 45° without air drag (it is not very much for a streamlined body) is about 4 km, the altitude is 1.4 km, and the jump time is about 20 seconds. The cross-section area of all the cables is $S = Ma/\sigma$ = 1000×80/200/10^2 = 40 mm^2 . Cable mass is $m = SL\gamma$ = 40×10^{-6} × 250×1800 = 18 kg. The restored in landing except for the air drag loss of 10–20%. If we have an energy accumulator, an engine with 500–800 kW power will be enough for this device. The vehicle can have a small wing (area 2 m^2) and glide from an altitude of 1.4 km for a distance of 14–17 km to the selected place for the next jump.

e) Long arm (long hand) (Fig. 25b). The proposed method allows us to create a "long arm" which suspends a video camera or weapon aloft. Assume the load mass of the long hand is M = 2 kg and the hand has a length of 1 km. The hand uses a steel cable with σ = 100 kg/mm^2 and γ = 7.9 g/cc. Maximum speed is

$$V = \sqrt{\sigma/\gamma} = \sqrt{10^9/7900} = 356 \text{ m/s.} \qquad (21)$$

The cross-section area is $S = M/\sigma$ = 2/100 = 0.02 mm^2, d = 0.08, s = 1 mm, and the cable mass is $m = SL\gamma$ = 0.02×10^{-6}×1000×7900 = 158 g. The cross-section area parameter is $L_s = L^{0.8} s = 1000^{0.8} \times 0.001 = 0.25$. The cable drag is D = 20 N (Fig. 10 or equations (9) – (10)), and the required engine power P = 6.8 kW (Fig. 11). The operator (e.g. a soldier) can observe regions within a 1 km radius and immediately apply the weapon if necessary. The radius may be increased up to 10 km. If using a more powerful kinetic anti-gravitator that can hold a load of 200 kg with a net and catcher installed at the end of the cable, the operator can catch the soldier and deliver him or her to another place. This may be very useful for rescue and anti-terrorist operations.

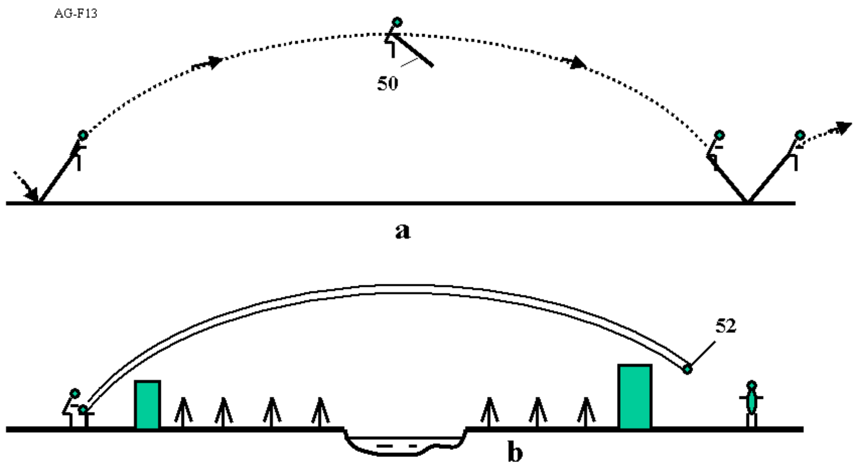

Fig. 21a: "Superman" using the jump kinetic anti-gravitator (50). **b**) The super-hand (52), which allows operation at long distances of 1–10 km.

10. High altitude crane

The construction of skyscrapers needs high cranes. Consider the design of a crane of $L = H = 500$ m height using the offered method. Take the useful load as 1 ton and the steel cable as having safe tensile stress of $\sigma = 50$ kg/mm^2 and cable density of $\gamma = 7.9$ g/cc. The total cross-section cable area is (equation (8)) $S = F/(\sigma - \gamma g H) = 22$ mm^2. The cable mass is $m = S\gamma H = 2\times10^{-6}\times500\times7900 = 87$ kg, and safe cable speed is $V = (\sigma/\gamma)^{0.5} = 250$ m/s. If the installation has four cables of diameter $d = 2.6$ mm each, the total perimeter of the four cable is $s = 4\pi d = 33.2$ mm, the parameter $L_s = L^{0.8} s = 500^{0.8}\, 0.0332 = 4.8$, the cable air drag is $D = 200$ N (Fig. 10, equation (9-10)), and the required power to support cable rotation is $P = 50$ kW (Fig. 11, equation (10)). This is the highest (500 m) and the lightest (87 kg) crane in the world having a load capability of 1 ton.

11. High tower

Consider the design of a high tower of $L = H = 4$ km using the offered method. Take the useful load as 30 tons and the steel cable as having a safe tensile stress of $\sigma = 50$ kg/mm^2 and cable density of $\gamma = 7.9$ g/cc. The total cross-section (all branches) of the cable area is (equation (9.4)) $S = F/(\sigma - \gamma g H) = 1630$ mm^2. Cable mass is $m = S\gamma H = 51.5$ tons, and safe cable speed is $V = (\sigma/\gamma)^{0.5} = 250$ m/s. If the installation has four cables, the diameter of one cable is $d = 23$ mm, the total perimeter of the four cable is $s = 4\pi d = 0.289$ m, the parameter $L_s = L^{0.8}s = 4000^{0.8} \cdot 0.289 = 220$, the cable air drag is $D = 9500$ N, and the required power to support cable rotation is $P = 2.3$ MW. This is highest (4 km) and the lightest (52 tons) tower in the world, which has a load capability of 30 tons at the top.

Conventional steel cable has a maximum tensile stress of $\sigma = 300$ kg/mm^2 and density of $\gamma = 7900$ kg/m^3, and fiber steel cable has a tensile strength of about $\sigma = 2000$ kg/mm^2. At present, industry widely produces cheap artificial fibers with a maximum tensile stress of $\sigma = 500$–620 kg/mm^2 and density[10.11] $\gamma = 800$–1800 kg/m^3. Whiskers have $\sigma = 2000$–8000 kg/mm^2 and density[10] $\gamma = 2000$–4000 kg/m^3, and–1800 kg/m^3. Theory[11] predicts that nanotubes can have $\sigma = 100{,}000$ kg/mm^2 and density $\gamma = 800$ –1800 kg/m^3. We will consider a double closed-loop cable in projects below. We will also use the conventional steel cable that has confirmed (safety, permitted) tensile stress of $\sigma = 50$–100 kg/mm^2 or the conventional fibers with a maximum confirmed strength of $\sigma = 200$ kg/mm^2 and density $\gamma = 1800$ kg/m^3. This means the safety factor is 3–6 or 2.5–3.1. The use of whiskers or nanotubes dramatically improves the parameters of the kinetic anti-gravitator for long distances.

12. Discussion

According to Eli Yishai, one of four Deputy Prime Ministers, and Minister of Internal Affairs in 2011 revealed that at that time, Israel faced over 100,000 missiles

“In a speech to Shas activists in the north on Monday Yishai said "this is a complicated time and it's better not to talk about how complicated it is. This possible action is keeping me awake at night. Imagine we're [attacked] from the north, south and center. They have short-range and long-range missiles - we believe they have about 100,000 rockets and missiles." [18].

"It's difficult to sleep at night when you know what is going on," said the minister, in an uncharacteristically dramatic statement. "Remember the Second Lebanon War, how many missiles there were – the entire North ran away. Imagine the North, Center and South… I do not want to scare anyone, but the missile array of Hamas, Hizballah and the Syrians, the approximate number of long and short-range missiles approaches 100,000 missiles. Try to calculate G-d forbid what that can do." [19].

In an updated estimate of what missiles are in Gaza alone, at the start of the summer 2014 conflict, Hamas had approximately 12,000 rockets of various ranges, including long-range rockets. It fired approximately 4,600 rockets during the 50-day war, and roughly 4,000 more were hit from the air in Israeli bombardments. That left the terror group with about one-third of its original arsenal. [20] Every estimate before a war has been wrong as to quantity: It is implausible they have fewer than 50,000 rounds and more than 500,000. Until a war starts, the extent of their arsenal is unverifiable, and then it is too late.

Projectiles and Mortar Shells

Composed of inexpensive materials, the short range Kassem missiles have bombarded Israel mainly from Gaza but at times from the Sinai Peninsula. These projectiles are strong enough to penetrate buildings and kill and maim by shrapnel. The effects include:

- Horror of sudden death wears down morale.
- Even dud Qassams can cause slow erosion of a city.
- Forces people to flee city en masse.
- Fleeing cities can greatly complicate defense mobilization.

If Israel can't mobilize, it can lose a war!

Israel's various opponents are developing an ability to salvo 100 missiles an hour for weeks**.** Routine alerts that destroy normal life, are eventually ignored. Ignoring enemy fire– even duds– also discourages Israelis believing that their government cares. Israel must also be prepared for escalation.

Window Breaking Distance

Danger is not just from direct hits, but sizeable explosions can blow out all glass in a city. It is impossible to replace windows in a whole city in less than a half year– imagine this happening during a cold rainy winter! There is a significant danger of horrible injuries from glass blowout. The computations are as followed:

- 1 PSI—11 miles = 17.702784 kilometers from 1 megaton
- ~ 4 km from 20 kilotons
- ~ 170 meters from 1-ton warhead

Spread of Bombardment

In 1991, Saddam Hussein bombed Tel Aviv. For a month and a half, long-range missiles landed on the city. In 2006, every major city in northern Israel was hit, including Haifa, Nazareth, Tiberius, Nahariya, Safed, Afula, Kiryat Shmona, Karmiel, and Maalot, along with dozens of kibbutzim, moshavim, and Druze and Arab villages. During the 2006 war, a total of 1012 Katyusha missiles hit Kiryat Shmona. Approximately half of the city's residents had left the area, and the other half who remained stayed in bomb shelters.

Effect of Bombardment

- Kiryat Shemona 2006: evacuation of more than 350,000
- 2001-2008 Missile bombardment of Sderot and Western Negev -Israel managed to attack 7,000 targets in 34 days from the air, the result of Israel's ability to combine real-time intelligence with air force power. Out of the 7,000 targets, about 1,000 were pre-planned.

Israel is often bombarded from Gaza, over 15,000 missiles since the 2005 withdrawal, putting nearly one million Israeli citizen citizens under direct threat every day. [21] Over 6,000 have hit Sderot since the evacuation from Gaza. What the residents of Sderot, Ashkelon, and environ, are qassam missile. Range of missiles launched from Gaza is illustrated in Fig. 22.

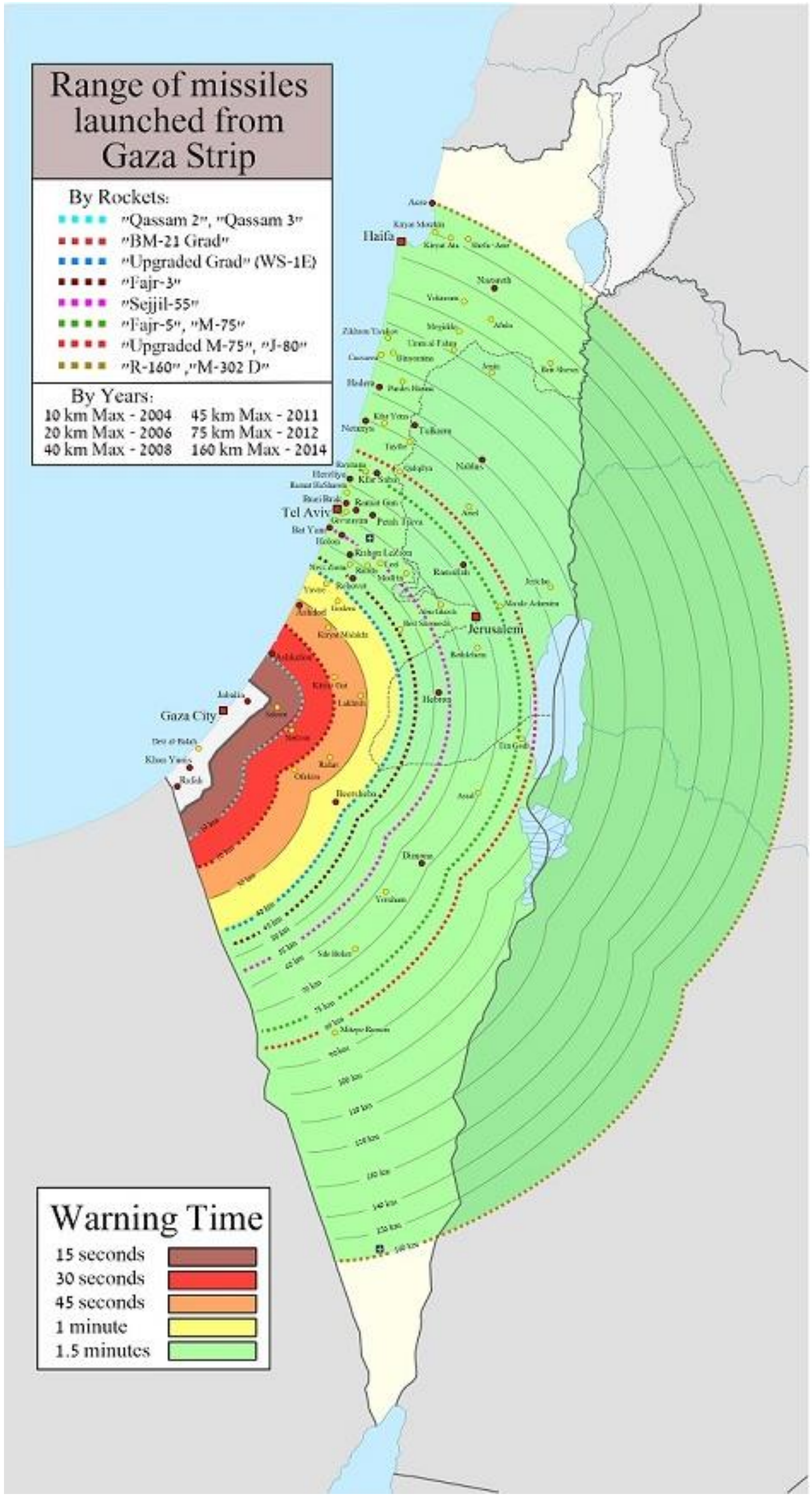

Fig. 22: Hamas Missile Ranges. Although some of their medium range missiles reached Tel Aviv and Jerusalem, which by and large are downed by Iron Dome, the closest targets are less protected. These are the locations frequently targeted.

Iron Dome is effective if they never run out of interceptors, but reality is within a week (even with the trick of only intercepting the ones that would do damage), it is expected that it will start having to conserve defenses to vital targets like Dimona or Ben Gurion. Lebanon (Fig. 23) and Gaza are now launching pads.

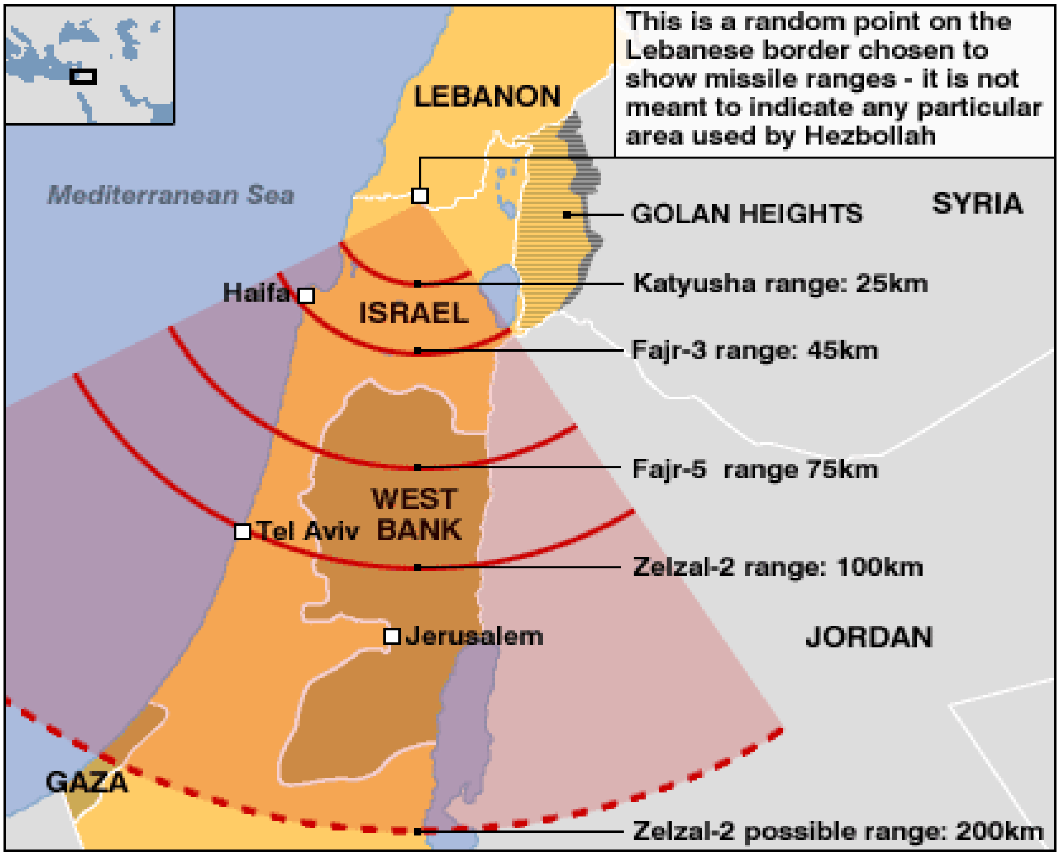

Fig. 23: Range of Missiles Launched from Lebanon

Right now, the infrastructure for simultaneous multi-front launches are being put in place by Iranian proxies. Hezbollah in Lebanon and Syria and Hamas in Gaza, and from Iran itself.

Applications of Retractable Kinetic Tower for National Defense

General positive trends in security should not obscure the erosion of security: The gradual buildup of enemy strike capability, in the hundreds of thousands of rounds and the erosion of deterrence so nearly every day some new provocation occurs. Government spokesmen say they will not tolerate strikes from Gaza but of course they do. Negligence toward border defense will destroy the State's relation with border communities. As such, Israel is in dire need of a technology that can comprehensively protect civilian and governmental centers from missiles, fire kites, fence approaches and other increasing threats. Patriot, Iron Dome and other anti-missile missiles are prohibitively expensive and do not effectively stop all but the most hittable short-range missiles. The proposed kinetic tower fills this unique position in this situation. Three such kinetic towers could throw up a point anti-missile barrier on demand over a vulnerable target. If 5-kilometer range can be established for each kinetic tower, 20 could provide real time protection for the entire Gaza border (with appropriate weapons heads fitted)

Application of Kinetic Tower to Stop Border Infiltrations, Fire Kites and Snipers

More recently, the Gaza demonstrations and infiltrations by way of under the wall tunnels or over the wall incendiary kites which destroyed more than 17,000 dunam of crops (a dunam is 1/1000th square kilometer) and nature reserve highlight the impotence of a purportedly strong army which sparingly used live ammunition where there was clear and present danger to the lives of Israelis, but the diplomatic backlash was relentless.

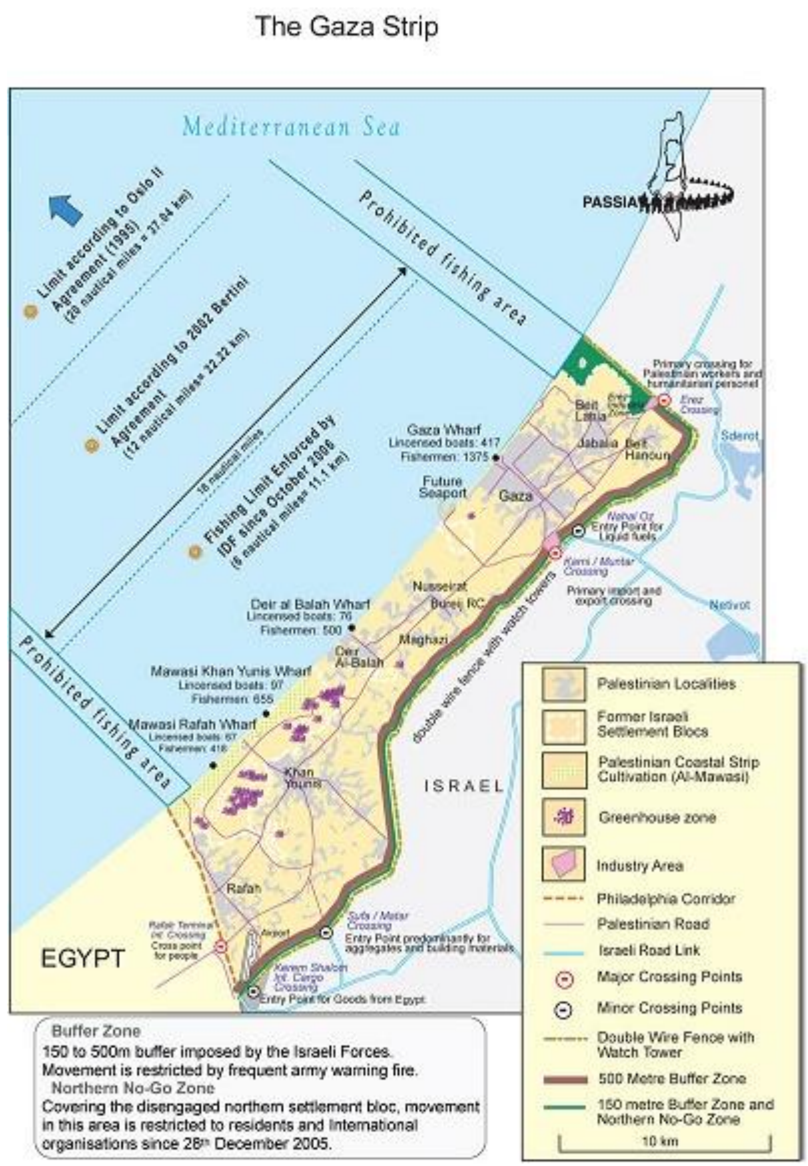

Fig 24: Map [22] by The Palestinian Academic Society for the Study of International Affairs [23].

Several kinetic towers rising up to meet the challenge of enemy combatants using women, children and medics as shields, could employ technologies at heights to repel groups from approaching the border. It is even possible to snatch an individual from the surface and capture him to a height with the right equipment, in seconds. It would take about twenty kinetic towers to fully cover Gaza's border, (Fig. 24) and about 30-40 to provide a full range of useful capabilities including intercepting flyby missiles.

For example, one Active Denial System, [24] a US nonlethal crowd-control device firing a beam of 94-Ghz microwaves (known as millimeter waves) could have a horizon and range sufficient to cover almost half a kilometer of the border, certainly the most troublesome and densest areas, all at once. It is certain that a dozen such devices rearing up at unpredictable places and times, could give the most determined group of people pause, certainly after the first painful exposure. The problem is the actual US ADS is not terribly practical in terms of its power supply logistic train or anything else. But there are other designs of crowd repellent that would be practical to deploy, though not as safe.

And in another configuration, this can act as a "long arm" to extract someone from up to 10 km. This would enable interventions anywhere in Gaza from our side of the border without using drones. The key is constant variable height surveillance of the border and instant reaction without needing to trigger a drone launch which can give pre-warning to enemies and blind spots of coverage during sortie rotation.

Empirical Validation and Proof of Concept

At the end of the day this is an empirical question. If this device is built and is operational, then it is a question of scalability. A cowboy can trill a lasso in either horizontal or vertical position Fig. 25 (for video illustration, references [25, 26]). These same forces that enable the lasso to maintain its shape if force is exerted are the same ones underlying the kinetic tower. However, proof of concept requires a working small-scale model of kinetic tower functions. Such a small-scale device has been constructed and proved to be functional as shown in Fig. 26.

Experiments requested by author and performed by Mr. Gregory Lishanski in 2002– 2003 show the revolving straight closed-loop cable is stable in the vertical and horizontal positions. (Fig. 26) Lishanski's experiments provide empirical evidence that kinetic anti-gravitator creates a permanent controlled force. If the distance between bodies does not change, the kinetic anti-gravitator requires only a small amount of energy to compensate for the friction in the rollers and air. This is certainly true below sonic velocity.

Fig. 25: Lasso trilled in vertical position.

Fig. 26: Rotated closed-loop cable-vertical position.

Summary

While Israel possesses early warning systems after the launch, it needs a mechanism to view actions before the launch not just to make its reprisals accurate, but more importantly to prevent the launch. Kinetic Towers on the bed of trucks which are hidden from view by the security wall, can be driven to driven to locations which intelligence reports make suspect, and the antenna like kinetic tower rises to heights to see suspected locations and strike before the launch. Alternatively, the kinetic tower can be used to launch aircraft such as inexpensive and motor less gliders to observe and deliver a payload at the site of the launch. As these gliders are inexpensive and low tech compared to hi-tech gliders currently in use.

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Portions of this paper is reproduced from Chapter 9 in “Non-Rocket Space Launch and Flight” by Alexander Bolonkin. Originally presented as paper IAC-02-IAA.1.3.03 at Would Space Congress 2002, 10-19 October, Houston, TX, USA, a detailed manuscript was published as Bolonkin A.A. Kinetic Towers and Launchers, JBIS, Vol. 57, No.1/2, 2004, pp.33-39.

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